Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Implementation of Section 6002(b) of the Omnibus Reconciliation Act of 1993	)	WT Docket No. 11-186
	)	
Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Including Commercial Mobile Services	)	

COMMENTS OF MOBILE FUTURE

Mobile Future, a diverse coalition of cutting-edge technology and communications companies, consumers, and non-profit organizations, working to support an environment which encourages investment and innovation in the dynamic U.S. wireless sector, respectfully submits these comments in response to the Federal Communications Commission's ("FCC" or "Commission") public notice soliciting input and data for its Sixteenth Annual Report on the State of Competition in Mobile Wireless.[1] Mobile Future urges the Commission to acknowledge the significant competition in the mobile arena and provides several reports which illustrate the U.S. wireless community's clear leadership in the mobile revolution, offering the most advanced devices and innovative products to its customers, and warning of the dire consequences of inaction with respect to reallocation of spectrum for wireless.

I. There is an Urgent Need for Additional Wireless Spectrum.

Today's wireless marketplace is extremely competitive, with mobile players across the sector actively competing to provide consumers with access to the most innovative devices, products

[1] Wireless Telecommunications Bureau Seeks Comment on the State of Mobile Wireless Competition, *Public Notice*, WT Docket 11-186 (rel. Nov. 3, 2011).

and services. As the FCC and other experts have clearly documented, the exploding consumer demand for mobile technologies is leading to a situation where the nation faces significant spectrum exhaust. Without immediate resolution, this spectrum exhaust could limit consumer opportunities and cripple wireless innovation in just two years, according to the FCC's own data.

With competition driving increased consumer demand, there is a vital need to reallocate spectrum for wireless services without delay, and the consequences of failing to do so are severe. A recent study by Peter Rysavy, *The Spectrum Imperative: Mobile Broadband and Its Impacts for U.S. Consumers and the Economy*[2], provides a comprehensive engineering analysis of the potential consequences for consumers and wireless innovation if no action is taken. The study outlines how spectrum affects network capacity, how applications and devices create heavy data traffic, and the resulting spectrum shortage once available capacity has been consumed.[3]

The Spectrum Imperative points out that "over the last four years, consumers have increasingly come to rely on their wireless broadband devices for high-bandwidth applications."[4] This increase is driven by uses in telemedicine, distance learning, mobile business applications, and social networking, to name a few. To accommodate the growing demand for data-intensive content over mobile networks, providers need more spectrum for the fast and powerful technologies with which mobile devices operate. Without additional spectrum, the demand for U.S. wireless networks will outstrip capacity in as little as four years' time.[5] The FCC has also estimated that mobile data demand will "exceed available capacity by 2013, and will reach a

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[2] *See* Attachment A. Peter Rysavy, *The Spectrum Imperative: Mobile Broadband Spectrum and Its Impacts for U.S. Consumers and the Economy*, (Mar. 16, 2011) *available at* http://www.rysavy.com/Articles/2011_03_ Spectrum_Effects.pdf.
[3] *Id*.
[4] *Id*. at 9.
[5] *Id*. at 17.

nearly 300 MHz deficit by 2014."[6] Other studies corroborate these findings, stating that U.S. mobile networks are currently operating at 80 percent of capacity, well above the aggregate utilization rate of 65 percent for all countries worldwide.[7] Wireless operators urgently need more spectrum to continue to compete effectively and provide consumers with access to the fastest, most innovative mobile services and products.

II. Expanding Mobile Broadband Will Create Thousands of Jobs and Contribute to U.S. Economic Growth.

Creating efficiencies and reallocating more spectrum for mobile broadband will ensure that U.S. consumers continue to enjoy access to the wireless technologies they are increasingly relying on. In addition, mobile broadband will give a much-needed boost to the nation's economy by creating hundreds of thousands of new jobs through various avenues and contributing more than $200 billion to the U.S. GDP with the repurposing of spectrum for wireless.

The power of mobile broadband has been acknowledged by both the Commission and the Administration as a catalyst for economic opportunity and growth. President Obama has noted that high-speed wireless service is the way to spark new innovation, investment and jobs.[8] The Commission's Connect America Fund will help extend broadband infrastructure to millions of consumers currently without access and the Commission projects it will create approximately 500,000 jobs in rural America over the next six years as a result.[9]

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[6] *Mobile Broadband: The Benefits of Additional Spectrum*, FCC Staff Technical Paper, (Oct. 2010) at p. 18 *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-302324A1.pdf.

[7] Credit Suisse, *Global Wireless Capex Survey – A Multi-year Spending Cycle*, (July, 2011).

[8] *Remarks by the President on the National Wireless Initiative in Marquette, Michigan* (Feb. 10, 2011) *available at* http://www.whitehouse.gov/the-press-office/2011/02/10/remarks-president-national-wireless-initiative-marquette-michigan.

[9] *FCC Releases 'Connect America Fund' Order to Help Expand Broadband, Create Jobs, Benefit Consumers*, FCC News Release (Nov. 18, 2011) *available at* http://transition.fcc.gov/Daily_Releases/Daily_Business/2011/db1118/DOC-311095A1.pdf.

Additionally, reallocating more spectrum for mobile will continue to support intense competition while spurring investment and economic growth in the U.S. economy. A recent study, *Private-Sector Investment and Employment Impacts of Reassigning Spectrum*, by David Sosa and Marc Van Audenrode of the Analysis Group[10], explains how robust private sector investment in mobile broadband can be further stimulated by the reassignment of spectrum to wireless.

The economic benefits of reassigning spectrum to mobile broadband are immense. The study finds that reassigning 300 MHz of spectrum over five years will spur $75 billion in new capital spending, creating more than 300,000 jobs and $230 billion in additional GDP.[11] Following that, the release of an additional 200 MHz of spectrum within 10 years will create an additional 200,000 jobs and increase GDP by another $155 billion.[12] Drs. Sosa and Van Audenrode conclude that facilitating the reallocation of underutilized spectrum, policymakers can create a favorable environment for private sector investment that in turn will create jobs, spur demand, and encourage innovation.[13]

Providers compete to give consumers access to the latest, most powerful technologies by investing and creating economic opportunities. The urgent need for more spectrum, caused by soaring consumer and business demand for mobile broadband, will advance a powerful engine of economic growth and unleash mobile innovation.

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[10] *See* Attachment B. David Sosa and Marc Van Audenrode, *Private-Sector Investment and Employment Impacts of Reassigning Spectrum*, (Aug. 2011) *available at* http://www.mobilefuture.org/page/-/spectrum-impact-study.pdf?/spectrumjobs.
[11] *Id*. at 1-2.
[12] *Id*. at 2.
[13] *Id*. at 8.

III. The United States Is A World Leader In Wireless Services.

Two recent international comparisons by Roger Entner of Recon Analytics clearly show significant competition and leadership in the US wireless marketplace that directly benefits American wireless users. *International Comparisons: The Handset Replacement Cycle*[14] found that Americans replaced their mobile device after one year and nine months in 2010, far faster than consumers in any other country. The key factor driving rapid replacement cycles in the United States is handset subsidization, which was found to be far more important than other factors such as income levels.[15] Handset subsidization leads to a faster replacement cycle, which allows US consumers to have access to the latest devices and mobile innovations. Wireless providers compete by providing access to the latest and most powerful technology and services.

In the United States, carriers subsidize the over 630 devices that are available from at least 32 different manufacturers, allowing consumers and business to take advantage of new technologies that lead to new services, enhanced efficiency, and new revenue streams. Consumer demand for these products and services has driven mobile development, serving as a key competitive force.

The second report, *What's It Worth To You? Comparing Wireless Pricing in 14 Countries*, shows that U.S. consumers use five times the wireless services at more affordable rates than their counterparts in other countries around the world.[16] Americans consume more wireless minutes, messages and data than anywhere else in the world. However, the study shows that U.S. consumer spending on wireless voice and data combined dropped more than $4 per month from 2007 to 2010.[17] In addition, American consumers enjoy the lowest per-minute costs

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[14] *See* Attachment C. Roger Entner, *International Comparisons: The Handset Replacement Cycle*, (June 23, 2011) *available at* http://www.mobilefuture.org/page/handset-replacement-cycle.pdf.
[15] *Id*.
[16] *See* Attachment D. Roger Entner, *What's It Worth To You? Comparing Wireless Pricing in 14 Countries*, (Aug. 24, 2011) *available at* http://www.mobilefuture.org/page/-/entner-pricing-comparison-082411.pdf?/globalspending.
[17] *Id*.

for talk time, with one minute of average work earnings in the U.S. buying 19 minutes of talk time – nearly four times more minutes than the second most affordable country, Finland.[18]

IV. Conclusion

Today's wireless market is driven by fierce competition and exploding consumer demand. The sector is continually evolving and expanding to both increase mobile innovation and to meet and often anticipate consumers' voracious mobile appetites. As a result, we see US consumers using more wireless services at lower prices than their counterparts around the world. Policymakers have a clear responsibility to fully understand the rapid evolution in the mobile sector as well as to maintain a climate that encourages continued competition, investment and innovation to ensure that consumers and the nation's economy benefit fully from the vast potential of the mobile marketplace.

Respectfully submitted,

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[18] *Id*.

ATTACHMENT A

The Spectrum Imperative:

Mobile Broadband Spectrum and its Impacts for U.S. Consumers and the Economy

An Engineering Analysis

March 16, 2011

http://www.rysavy.com

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Executive Summary

The purpose of this report is to analyze, from an engineering perspective, the consequences of failing to make new spectrum available to consumers, the economy and the wireless sector. This report discusses how spectrum relates to capacity, how different types of applications and devices can consume available capacity, and the effects of insufficient spectrum.

For consumers, these effects include unreliable service and performance and potentially higher connectivity costs—a development that would place an essential modern service out of the reach of many Americans, including those who stand to gain the most from all that mobile connectivity has to offer. To the extent that service providers respond to capacity constraints by limiting demand through usage caps and significantly higher pricing, consumers' ability to access the Internet may be limited or come at a higher cost. These effects will particularly harm those, including many minorities and low-income Americans, who primarily rely on their mobile devices to access the Internet. This in turn rolls back the promise of mobile connectivity and innovation, denying access to critical services and opportunities.

The market consequence of such an environment will be less incentive for businesses to invest in new applications, services and devices because performance, and thus customer enthusiasm, will likely be subpar. This jeopardizes the 2.4 million American jobs currently supported by mobile innovation. And, the ultimate price of this downward spiral is a loss of U.S. leadership in the global innovation economy.

Introduction

U.S. mobile innovation continues to surge forward, fueled by a combination of faster networks, powerful next-generation wireless devices, including smartphones and tablets, and innovative applications that take increasing advantage of our constant state of connectivity. Lifestyles are enhanced and work is more productive, as the full and growing value of the Internet is increasingly ever-present and accessible in the palms of our hands.

Compelling data already exists to illustrate the important role that mobile technology plays in powering our innovation economy and empowering American consumers and businesses. And, we see clear evidence today that wireless broadband is helping to bridge the digital divide, with minority and lower-income Americans increasingly turning to mobile services as their primary connection to the Internet.

The number of U.S. consumers with broadband access on their mobile device has risen from three million in 2006 to 73 million in 2008.[1] As early as 2014, more people may go online via mobile devices than PCs.[2] And, within this decade an estimated 10 billion devices—from the medical tablet at the

[1] Source: "US Broadband Ranking: Does it Matter?," *PC WORLD*, June 5, 2009.

[2] Source: Mobile Internet Report, *Morgan Stanley*, December 2009.

hospital, to the textbook in your child's school to the thermostat in your home—will be perpetually connected thanks to ubiquitous wireless broadband technology.[3]

Mobile broadband is providing new business opportunities across vertical markets, including the automotive, banking, consumer electronics, transportation, and utilities industries. Already, there are vehicle accident recovery applications, mobile payment and online banking applications, remote health monitoring devices, smart utility meters, refrigerators, picture frames, pill bottle caps, traffic lights, and parking meters that use mobile technology. Mobile connectivity is poised to transform virtually every sector of the U.S. economy—from commerce to health care, education to energy efficiency. This mobility-enhanced world, however, depends on a constant, reliable flow of bits between people, devices and the Internet. As mobile devices become more powerful, as device resolution increases, as users employ more applications and as connectivity increasingly is embedded in virtually every manner of machine, this flow of bits is increasing at a dramatic rate.

The amount of bandwidth available to each user depends on many factors. But one of the most critical is the amount of radio spectrum available. As FCC Chairman Julius Genachowski has stated, "the explosive demand for wireless innovation is testing the limits of a fundamental resource: spectrum. It is the oxygen of the wireless world — fueling every aspect of our mobile broadband ecosystem."[4]

Cisco recently reported that in 2010, global mobile data traffic grew 2.6 fold, nearly tripling for the third year in a row.[5] Within three to four years, Rysavy Research estimates that our nation's appetite for wireless consumption could outstrip existing capacity. While carriers will attempt to alleviate congestion in the short-term by offloading traffic using femtocells and picocells, mobile innovation will falter without access to the substantial additional spectrum that American consumers and businesses will soon need, and the consequences of inaction for the nation are unacceptable.

Recognizing the urgency of the situation, the Obama Administration and the FCC plan to make 300 MHz of new spectrum available over the next 5 years and 500 MHz over the next 10 years,[6] almost double the 547 MHz of spectrum currently licensed for mobile broadband.[7]

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[3] Source: *Id*.

[4] Source: *The Hill*, "Spectrum: oxygen of wireless world," Julius Genachowski, September 24, 2009. http://thehill.com/special-reports/technology-september-2009/60265-spectrum-oxygen-of-wireless-world.

[5] Source: *Cisco*, "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2010-2015," February 1, 2011.

[6] Source: *FCC,* "Connecting America, The National Broadband Plan," March 2010; The White House, Presidential Memorandum: Unleashing the Wireless Broadband Revolution (June 28, 2010). http://www.whitehouse.gov/the-press-office/presidential-memorandum-unleashing-wireless-broadband-revolution.

As consumers race to embrace all that wireless broadband connectivity has to offer and U.S. mobile innovation continues to advance at an astounding pace, there is a clear and compelling national interest in ensuring adequate spectrum is available to continue this progress. Unfortunately, we cannot simply flip a switch and make more broadband spectrum available; it typically takes several years for spectrum to be repurposed and released into the marketplace.[8] And the clock is ticking with rising demand rapidly closing the gap with existing supply. The consequences of inaction are severe, widespread and wholly negative for consumers and the U.S. economy. Equally true, these substantial adverse impacts can be averted with bold and timely leadership today.

Spectrum and Capacity

To understand why additional spectrum is so crucial, one must understand how spectrum relates to capacity and how quickly users can consume what is available to them. This is especially true for consumers who live in population-dense urban environments, where the upper limits of current spectrum capacity are likely to first be reached and tested.

Modern wireless networks are digital, meaning they communicate binary data. The amount of data that a radio channel can carry depends on the width of the radio channel, the modulation used, and how the data is encoded. Each wireless technology uses radio channels of certain width. For example, CDMA2000 (as used by Sprint and Verizon) radio channels are each 1.25 megahertz (MHz) wide whereas High Speed Packet Access (HSPA as used by AT&T and T-Mobile) radio channels are 5 MHz wide. Long Term Evolution (LTE) radio channels can range from 1.4 MHz in width to 20 MHz.

To derive capacity, we must look at this width of the radio channel and consider the average spectral efficiency of the technology in typical deployments. For this purpose, spectral efficiency is defined as how many bits per second a given amount of spectrum can carry and is measured as bits per second per Hz of spectrum. HSPA in typical deployments has a downlink (base station to mobile user) spectral efficiency value of about 1.0 bps/Hz.[9] This means a 5 MHz HSPA radio channel has an aggregate downlink capacity of 5 million Hz multiplied by 1.0 bps/Hz, which equates to 5.0 million bits per second, or 5.0 Mbps.[10] This is the total capacity in a cell sector[11] for that radio channel, a capacity that must be

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[7]Source: *FCC*, "Connecting America, The National Broadband Plan," March 2010, at 85, Exhibit 5-F.

[8] Source: *Id*. at 70, Exhibit 5-C.

[9] For a detailed discussion of spectral efficiency and spectral efficiency values of different technologies, refer to page 51 of Rysavy Research, "Transition to 4G," September, 2010, http://www.rysavy.com/Articles/2010_09_HSPA_LTE_Advanced.pdf. 1.0 bps/Hz assumes a high level of technology enhancement and most existing HSPA networks operate at spectral efficiencies only half or two thirds of this value.

[10] In general, modern wireless technologies operate more efficiently with wider radio channels. This effect is not taken into account in the calculations of capacity in this paper.

shared by multiple users. The 5 MHz radio channel actually translates to 10 MHz of spectrum used since there is a separate 5 MHz radio channel for the uplink.

LTE has a higher spectral efficiency and can operate in wider radio channels. For example, an LTE radio channel of 10 MHz has a downlink spectral efficiency value of 1.5 bps/Hz and would thus have a downlink capacity of 15 Mbps. There is also an uplink channel of 10 MHz with a typical spectral efficiency value of .65 bps/Hz, equating to an uplink capacity of 6.5 Mbps. Together, the LTE downlink and uplink channels consume 20 MHz of spectrum.

The question then is how much total capacity an operator actually has for mobile broadband. This depends on how much spectrum the operator has and the distribution of cell sites. More cell sites mean fewer people have to share the radio channel since that radio channel is servicing a smaller area. But there are limits to how many cell sites can be practically deployed, with most of the easiest-to-deploy locations already in use.

In addition, when evaluating the total capacity, the spectrum an operator needs to support voice and legacy services, such as 2G, will reduce the total amount of spectrum available for mobile broadband.[12] Rysavy Research estimates that for a typical operator, roughly 20 MHz is needed for voice service in any coverage area. Subtracting this spectrum requirement for voice from total typical amounts of spectrum that operators have, mobile-broadband technologies such as HSPA or LTE could be deployed to support mobile broadband service in about 30 to 80 MHz of spectrum in a coverage area, assuming a typical upper limit of about 100 MHz of total spectrum available to operators in any market. Six channels of HSPA, each 5 MHz wide (using separate channels for the downlink and uplink), would require a total of 60 MHz. Alternatively, three 10 MHz LTE channels would require 60 MHz and four 10 MHz LTE channels would consume 80 MHz. Note, however, that an operator only deploys as many radio carriers as needed to meet capacity requirements for that cell sector.

Table 1 shows how cell sector capacity relates to different technology configurations, including the number of radio carriers that might be deployed. For example, an HSPA operator that has deployed 2 HSPA radio carriers in a cell site would consume 20 MHz of spectrum and would have 10 Mbps of aggregate downlink capacity in each sector and 5 Mbps of uplink capacity in each sector. Note that other currently deployed broadband technologies such as EV-DO and WiMAX have a comparable spectral efficiency to HSPA.

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[11] Most cell sites are divided into three sectors, so each cell sector (pie-slice shape) represents one third of the coverage of a cell tower.

[12] For example, operators with HSPA, a 3G technology, also need some spectrum available for GSM, a 2G technology.

Table 1: Spectrum Used and Sector Capacity for Different Configurations

Technology	Radio Carrier Width (MHz)	Carriers	Total Spectrum Used (MHz)	Downlink Spectral Efficiency	Downlink Sector Capacity (Mbps)	Uplink Spectral Efficiency	Uplink Sector Capacity (Mbps)
HSPA	5	1	10	1.0	5	0.5	3
		2	20		10		5
		3	30		15		8
		4	40		20		10
		5	50		25		13
		6	60		30		15
LTE	10	1	20	1.5	15	0.65	7
		2	40		30		13
		3	60		45		20
		4	80		60		26

Note: LTE can be deployed in radio channels ranging from 1.4 to 20 MHz. 10 MHz is a typical initial configuration for some operators.

Now let's examine market conditions with respect to spectrum in two U.S. cities, Philadelphia and San Diego. In those two markets, there are at least five wireless carriers with 40 MHz or more of spectrum, according to the FCC's Spectrum Dashboard.[13]

In Philadelphia and San Diego, AT&T and T-Mobile offer GSM and HSPA service.[14] Clearwire offers a 4G WiMax mobile service in Philadelphia and has plans to launch 4G service in San Diego this year.[15] In Philadelphia, Sprint Nextel, through its relationship with Clearwire, has a 3G CDMA EV-DO and WiMAX service offering and offers 3G service in San Diego.[16] Verizon launched its 4G LTE service this past December and also offers CDMA EV-DO service in both markets.[17]

Using the mobile wireless penetration rate determined by the FCC in its latest competition report for the Philadelphia and San Diego Economic Areas against the U.S. Census Bureau's latest population data, the

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[13] The Spectrum Dashboard may not fully reflect all of the spectrum and ownership elements in the two markets but provides a useful proxy for this analysis. Source: *FCC*, "Spectrum Dashboard," http://reboot.fcc.gov/spectrumdashboard/searchMap.seam (last visited on Mar. 9, 2011); *Morgan Stanley*, "The Mobile Internet Report," 2009.

[14] Source: AT&T, http://www.wireless.att.com/learn/why/network/index.jsp?wtSlotClick=1-00245D-0-1&WT.svl=calltoaction (last visited Jan. 27, 2011); T-Mobile, http://t-mobile-coverage.t-mobile.com/4g-wireless-technology?uid=Coverage_2 (last visited Jan. 27, 2011).

[15] Source: Clearwire, http://www.clear.com/coverage (last visited Jan. 27, 2011); Craig Howie, "Tech Trends: Clear Mobile Device Lets You Take 4G (or 3G) Internet Access with You," *L.A. Times*, Nov. 29, 2010, http://articles.latimes.com/2010/nov/29/business/la-fi-clear-4g-20101130.

[16] Source: Sprint Nextel, http://coverage.sprintpcs.com/IMPACT.jsp?INTNAV=ATG:HE:Cov (last visited Jan. 27, 2011).

[17] Source: Verizon Wireless, "Verizon Wireless Launches The World's Largest 4G LTE Wireless Network On Dec. 5" (Dec. 4, 2010), http://news.vzw.com/news/2010/12/pr2010-11-30a.html; Verizon Wireless, http://aboutus.vzw.com/bestnetwork/network_facts.html (last visited Jan. 27, 2011).

estimated number of mobile wireless subscribers in Philadelphia is about 1.45 million and in San Diego, about 1.3 million.[18] There are an estimated 1,450 cell sites in Philadelphia and 1,200 sites in San Diego, with each site covering about 1,100 subscribers.[19] With three sectors commonly used at cell sites, we will assume there are about 360 subscribers per cell sector. In Philadelphia, there are an estimated 660,000 adults that access the Internet wirelessly and more than 570,000 in San Diego.[20]

The demographic makeup of these two cities is as follows:

- Of the more than 1.5 million residents in Philadelphia, 53.2% are female; 43.5% white; 42.7% black or African American; 11% Hispanic or Latino; 5.5% Asian; 76% are 18 years and older and 12.7% are 65 years and older.[21] The median household income in Philadelphia is $36,669, and the percentage of families and individuals that are below the poverty level are 19.2% and 24.2%, respectively.

- Of San Diego's 1.3 million residents, 49.7% are female; 66.7% white; 6.8% black or African American; 27.3% Hispanic or Latino; 14.8% Asian; 77.6% are 18 years and older and 10.7% are 65 years and older.[22] The median household income is $61,962, and the percentage of families and individuals that are below the poverty level are 8.8% and 13.1%, respectively.

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[18] Source: *Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services*, WT Docket No. 09-66, Fourteenth Report, 25 FCC Rcd 11407, 11644 Table C-3 (2010); US Census Bureau, http://factfinder.census.gov (search using "Philadelphia" and "San Diego") (last visited Jan. 27, 2011). Note we are using estimates based on generally available numbers.

[19] Source: Dr. Robert F. Roche & Lesley O'Neill, CTIA, "CTIA's Wireless Industry Indices," 161, November 2010, at 161 (providing mid-year 2010 results and calculating 1,111 subscribers per cell site). Cell site estimates based on the estimated number of subscribers in Philadelphia and San Diego against the average number of subscribers per cell site. Source: *Id*. at 8.

[20] Estimates based on percentage of American adults that have a wireless connection and use a laptop or cell phone to access the Internet as determined by the Pew Internet and American Life Project (Pew Internet), i.e., 57%, compared to the estimated population of people in Philadelphia and San Diego that are 18 years or older. Source: Susannah Fox, "Mobile Health 2010," Pew Internet (Oct. 19, 2010), http://www.pewinternet.org/Reports/2010/Mobile-Health-2010.aspx; U.S. Census Bureau, http://factfinder.census.gov (search using "Philadelphia" and "San Diego").

[21] Source: US Census Bureau, http://factfinder.census.gov (search using "Philadelphia") (last visited Jan. 27, 2011).

[22] Source: US Census Bureau, http://factfinder.census.gov (search using "San Diego") (last visited Jan. 27, 2011).

According to a recent report released by the Pew Research Center's Internet & American Life Project, minority groups are the leading demographic segment to adopt mobile services. Pew found that 63% of Hispanics and 64% of African Americans access the Internet wirelessly, more than whites at 57%.[23] Lower-income people, independent of race, also are increasingly likely to access the Internet wirelessly, according to Pew.[24] A National Health Interview Survey showed more than 26% of homes are wireless-only and do not have a landline telephone, with adults living at or near poverty more likely than higher-income adults to live in wireless-only households.[25] Moreover, Hispanic adults at 34.7% and black adults at 28.5% were more likely than white adults at 22.7% to be living in a wireless-only household.[26] Assuming these trends hold true, there is a higher percentage of residents in Philadelphia, and a higher percentage of Hispanics and Latinos living in San Diego, who rely on mobile broadband as their primary connection than the national average due to the demographics of these markets.[27]

As we will see in the next section, a relatively small percentage of the subscribers in Philadelphia and San Diego, and/or seemingly small shifts in the kinds of devices and/or applications commonly used, can easily overwhelm the available capacity of a given cell site antenna sector based on currently available spectrum.

Application and User Demands

In markets like Philadelphia and San Diego and around the country, ever more sophisticated applications present fast-growing demands on the network. Whereas e-mail and web browsing of relatively static content present a minimal load, streaming applications, such as the Pandora music or Netflix video applications, can consume large amounts of available bandwidth because this more data-intensive content has to be continually and reliably delivered. Over the last four years, consumers have increasingly come to rely on their wireless broadband devices for high-bandwidth applications. Even a seemingly subtle shift in time and consumption habits—or even upgrading a device—can drive up data usage by several orders of magnitude.

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[23] Source: Aaron Smith, "Mobile Access 2010," *Pew Research Center's Internet & American Life Project*, 3, 9 (July 7, 2010), http://www.pewinternet.org/Reports/2010/Mobile-Access-2010.aspx ("Mobile Access 2010).

[24] Source: Mobile Access 2010 at 9.

[25] Source: Stephen J. Blumberg and Julian V. Luke, "Wireless Substitution: Early Release of Estimates from the National Health Interview Survey, January-June 2010," National Center for Health Statistics, *CDC*, at 1, 3, Dec. 21, 2010, http://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless201012.htm.

[26] Source: *Id*.

[27] The population percentage of blacks and African Americans and Hispanics and Latinos for the entire U.S. is 12.1% and 15.1%, respectively, compared to 42.7% and 11% in Philadelphia and 6.8% and 27.3% in San Diego. Families and individuals below the poverty level for the entire U.S. are 9.9% and 13.5%, respectively, compared to 19.2% and 24.2% in Philadelphia. Source: US Census Bureau, http://factfinder.census.gov (search using "Philadelphia").

Table 2 shows the typical throughput requirements of various streaming applications that might include increasingly popular applications for telemedicine, education, social networking, entertainment, field service, business collaboration, and so forth. The table includes the amount of data each application consumes per hour measured in megabytes, and how many gigabytes each individual application would consume in a 30-day month based on daily consumption amounts of .5 hours, 1 hour, 2 hours and 4 hours.

Table 2: Data Consumption of Typical Applications

Application	Throughput (Mbps)	MByte/hour	Hrs./day	GB/month
Audio or music	0.1	58	0.5	0.9
			1.0	1.7
			2.0	3.5
			4.0	6.9
Small screen video	0.2	90	0.5	1.4
			1.0	2.7
			2.0	5.4
			4.0	10.8
Medium definition video	1.0	450	0.5	6.8
			1.0	13.5
			2.0	27.0
			4.0	54.0
Higher definition video	2.0	900	0.5	13.5
			1.0	27.0
			2.0	54.0
			4.0	108.0
High definition, full screen video	4.0	1800	0.5	27.0
			1.0	54.0
			2.0	108.0
			4.0	216.0

Video applications: telemedicine, education, social networking, entertainment.

The table demonstrates how relatively discrete use patterns can quickly result in large monthly data usage totals. For example, an hour of audio a day adds up to 1.7 gigabytes (GB) over a month. And, 30 minutes a day of medium-definition video consumes 6.8 GB.

Actual amounts of data being consumed in the marketplace validate these estimates. Clearwire indicated in 2010 that subscribers were already consuming 7 GB per month.[28] Teliasonera in Finland, the

[28] Source: Fierce Wireless, "Clearwire upgrades network management system to better throttle speeds," October 11, 2010, http://www.fiercewireless.com/story/clearwire-says-it-will-throttle-data-speeds-during-high-usage/2010-10-11.

first LTE operator, reported LTE data-card subscribers using 14 GB to 15 GB per month, three times their 3G data-card users.[29] This monthly amount is consistent with average fixed broadband consumption of 14.9 GB per month, as reported by Cisco.[30] If mobile broadband networks existed in isolation, operators might be able to manage performance expectations. But wireline networks with much higher capacities often set user expectations, resulting in users frequently wishing to do the same things over mobile networks as they do over wireline networks. With policymakers working to extend broadband to a larger percentage of the population while at the same time promoting broadband competition, it is crucial that mobile broadband be a competitive and viable alternative. This is particularly important if mobile broadband is to play an important role in sectors such as healthcare, education and energy.

Data usage across all device types is growing quickly. For instance, Rysavy Research projects smartphone data consumption increasing from about 0.3 GB per month to almost 10 times this amount within 5 years, as shown in Figure 1.[31]

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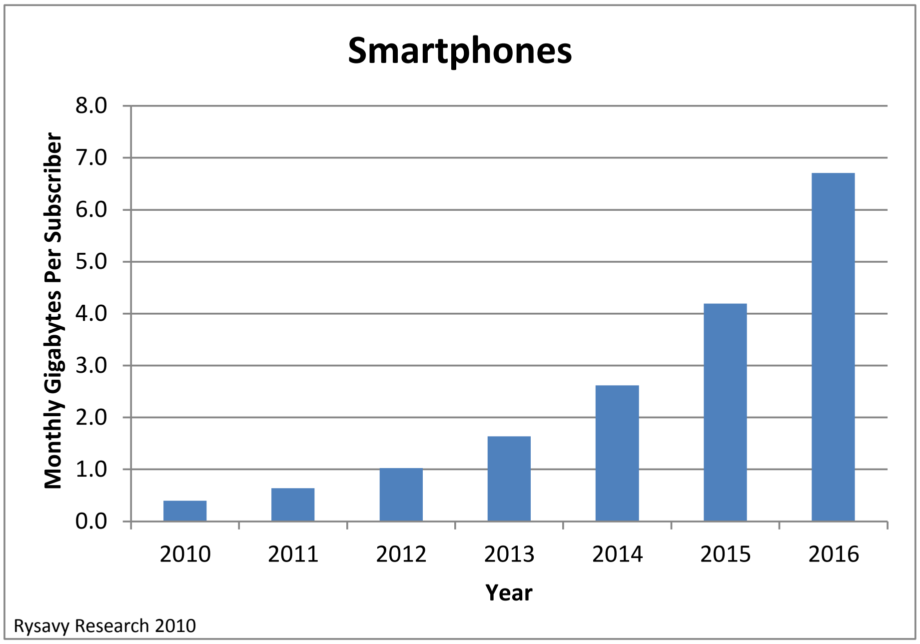
[29] Source: Gigaom, "Operator Says LTE Subscribers Using 15 GB Per Month!," November 15, 2010, http://gigaom.com/2010/11/15/wireless-vs-wired-broadband/.

[30] Source: Cisco, "Cisco Visual Networking Index: Usage," October 25, 2010, http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/Cisco_VNI_Usage_WP.html.

[31] Source: Rysavy Research, "Mobile Broadband Capacity Constraints and the Need for Optimization," February 24, 2010, http://www.rysavy.com/Articles/2010_02_Rysavy_Mobile_Broadband_Capacity_Constraints.pdf.

Figure 1: Smartphone Data Projection



Consumers are increasingly using mobile for telemedicine, distance learning, and social networking. In addition, there is a growing demand for mobile business applications by enterprise users. With the expected rapid growth in usage of new, data-heavy services and applications, it is critical to make more spectrum commercially available to accommodate growing consumer demand. It is important to note that emerging wireless applications such as machine-to-machine communications and tablet computing could result in far greater demand for capacity than amounts anticipated by simply extrapolations of current usages.

A variety of factors are fueling continued growth in usage, including: faster networks, more network-enabled devices, increasing computing speeds that enable more complex data-consuming applications, gaming, larger displays, and higher screen resolution.

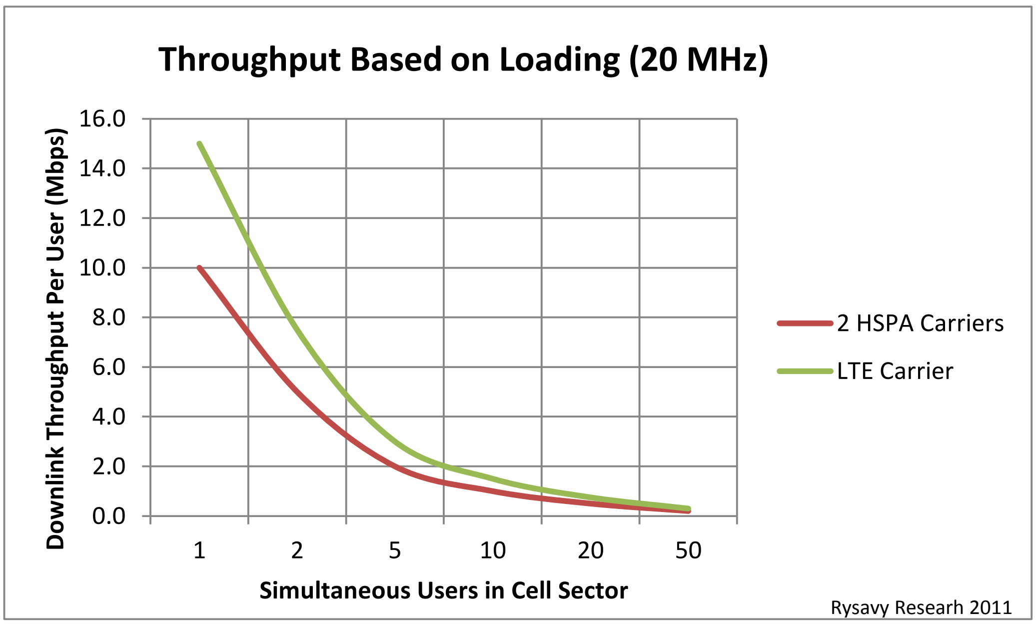
Taking just one of these factors, screen resolution, Table 3 shows how increasing resolution results in higher video encoding rates and increased broadband capacity consumption. Assuming typical advanced video encoding and full-screen video, going from the iPhone 3 to iPhone 4 quadruples the video data consumption rate. The third row presents a high-definition stream for comparison. The point is that even though devices are relatively small, increasing video resolution forces them to consume larger amounts of data. Thus, even if a consumer's usage of mobile video stayed constant – which is highly unlikely – bandwidth demands would skyrocket simply because of the shift in screen resolution.

Table 3: Typical Video Usage Rate Based on Type of Device

Device	Vertical	Horizontal	Megapixels	Typical Video Rate (Mbps)
iPhone 3	320	480	0.2	0.4
iPhone 4	640	960	0.6	1.6
1080p HD	1080	1920	2.1	5.4

To put these usage rates into a wireless-networking perspective, Figure 2 below takes the network capacities presented in Table 1 and shows what downlink throughput rates are available, based on the number of simultaneous users, assuming an operator is using 20 MHz for mobile broadband, e.g., Verizon uses 20 MHz for LTE.

Figure 2: Available Throughput Per User Based on Network Loading



The fact is that if users are engaged in 1 Mbps or 2 Mbps streams or downloads, it takes a relatively small number of users to consume sector capacity. For LTE, it takes only about eight users with a 2 Mbps stream to reach the 15 Mbps sector capacity that one operator may have deployed. As noted earlier in this report, there is an estimated average of about 360 subscribers per cell sector per operator. Denser cell sites in cities, like Philadelphia and San Diego, could have two or three times as many subscribers. To put this into perspective, cell-site spacing in an urban area could be 1,000 feet between cell sites, with each cell site covering about 10 city blocks. Since each site comprises three sectors, this means a sector has to cover about three city blocks. This sector capacity has to be shared across all the users in this area. Operators will augment capacity with additional radio channels, but doubling the amount of spectrum to 40 MHz using LTE would still only accommodate 16 simultaneous users consuming 2 Mbps streams.

Even if an operator with 100 MHz of total spectrum holdings had 80 MHz of spectrum allocated to LTE, this would still represent only about 60 Mbps of aggregate downlink capacity in a cell sector for those three city blocks, accommodating 30 simultaneous users consuming 2 Mbps streams in a given sector. However, unless more spectrum is made available, it is highly unlikely that even four providers could reach these spectrum holdings in a given market like Philadelphia or San Diego.

The FCC states that there is 547 MHz of spectrum currently licensed that can be used to provide mobile broadband.[32] In Philadelphia, this licensed spectrum is divided up among more than 20 different spectrum holders with no one entity holding 100 MHz.[33] Three major providers in Philadelphia have between 75 and 99 MHz and the next 4 have between 10 and 50 MHz. In San Diego, there are more than 30 spectrum holders.[34] The top four providers in San Diego have between 70 and 104 MHz; and the next two have between 30 and 40 MHz.[35] Unless more spectrum is made available, there would need to be significant consolidation in the Philadelphia and San Diego spectrum marketplace for there to be at least four providers with sufficient spectrum to reach the 60 Mbps of capacity necessary to support 30 simultaneous users of higher definition video in the three city blocks covered by a given antenna sector. In contrast, a single cable-modem user can readily obtain 15 to 50 Mbps of dedicated service.

Rysavy Research projects even an operator with 100 MHz of spectrum and 60 Mbps of aggregate sector capacity will not be able, absent additional spectrum, to meet the data demands of consumers in three to four years if consumers use the applications they desire.[36]

Of course, not all users are necessarily simultaneously engaging in high-bandwidth streaming activities. Users doing e-mail or browsing Web pages with relatively static content consume far less data. So operators can accommodate larger numbers of those kinds of users. The point, however, is that broadband users in general are increasing their data consumption at a steady rate. At the same time, the percentage of subscribers with devices that can consume large amounts of data is growing steadily. For example, the Nielsen Company found that 31% of American mobile consumers owned smartphones

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[32] Source: FCC, "Connecting America, The National Broadband Plan," March 2010, at 85.

[33] Source: *FCC*, "Spectrum Dashboard," http://reboot.fcc.gov/reform/systems/spectrum-dashboard (last visited on Mar. 9, 2011). Many of the spectrum holders in Philadelphia and San Diego are Educational Broadband Service (EBS) licensees. Commercial operators are allowed to lease excess capacity on EBS systems but are not eligible to hold EBS licenses.

[34] These spectrum amounts are rough estimates based on the FCC's Spectrum Dashboard. Source: *Id*.

[35] Source: *Id*.

[36] Source: *Rysavy Research*, "Mobile Broadband Capacity Constraints and the Need for Optimization," February 24, 2010, http://www.rysavy.com/Articles/2010_02_Rysavy_Mobile_Broadband_Capacity_Constraints.pdf.

as of December 2010 and more consumers will own smartphones than basic feature phones by the end of 2011.[37] Already today, these nimble tools generate 30 times the data traffic of basic-feature phones.[38] It is the combination of bandwidth-consuming devices and increasing penetration that is placing so much stress on mobile broadband capacity. This trend is now clearly accelerating with the arrival of new device categories, such as tablets, which are being enthusiastically embraced by consumers – 10.3 million tablets sold already with sales expected to exceed laptops by 2015.[39]

To accommodate rapidly rising volumes of data-rich traffic, operators will need to employ multiple approaches. One is to continue deploying more advanced wireless technologies as they become available.[40] Another is to offload data traffic onto alternate networks such as Wi-Fi and femtocells, which have inherently greater capacity due to their much higher frequency reuse. The other tactic, of crucial importance, is to deploy greater capacity in more spectrum, though this is only an option if spectrum is available to them.

Figure 3 shows how the throughput per user can dramatically increase through a combination of offload and more spectrum.

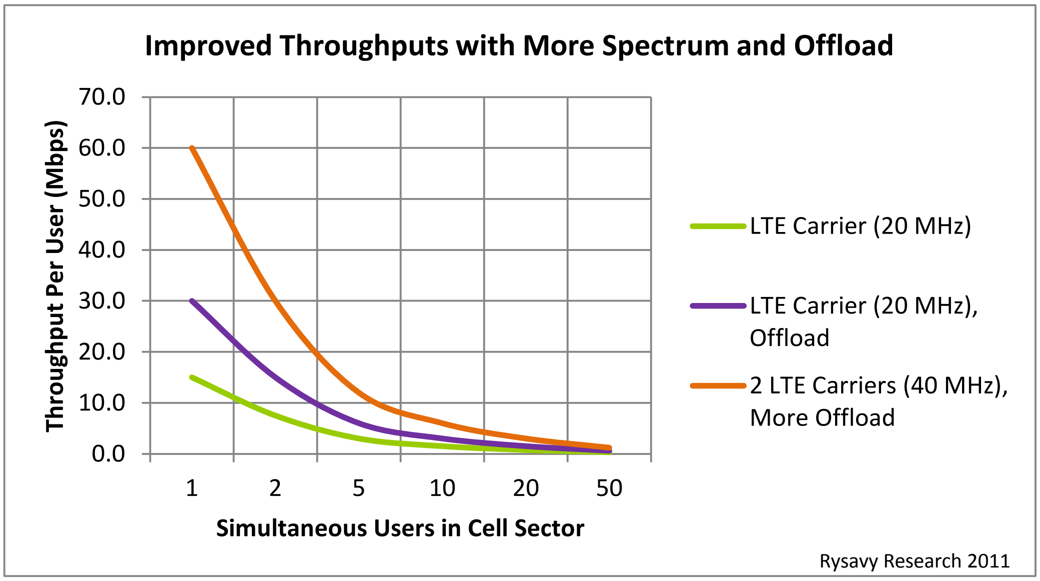
[37] Source: Don Kellogg, "Among Mobile Phone Users, Hispanics, Asians are Most-Likely Smartphone Owners in the U.S.", *NielsenWire*, Feb. 2, 2011, http://blog.nielsen.com/nielsenwire/consumer/among-mobile-phone-users-hispanics-asians-are-most-likely-smartphone-owners-in-the-u-s/#; Roger Entner, "Smartphones to Overtake Feature Phones in U.S. by 2011," *NielsenWire*, Mar. 26, 2010, http://blog.nielsen.com/nielsenwire /consumer/smartphones-to-overtake-feature-phones-in-u-s-by-2011/#.

[38] *Cisco Report*, 2009.

[39] Source: "Tablets to Surpass Laptop Sales In 2015, One Third Of US Consumers Will Own One," MobileMarketingWatch, Jan. 5, 2011, http://www.mobilemarketingwatch.com/tablets-to-surpass-laptop-sales-in-2015-one-third-of-us-consumers-will-own-one-12356/.

[40] For example, the evolution of LTE (through LTE Advanced) employs continually more advanced forms of smart antennas. Rysavy Research projections for required spectrum takes these advances into account.

Figure 3: Greater Capacity Through More Spectrum and Offload[41]



Additional spectrum will play a pivotal role among providers:

- Existing service providers with relatively large amounts of spectrum have huge subscriber bases already generating tremendous broadband demand. This demand will only increase and can only be accommodated with more spectrum.

- Service providers with smaller amounts of spectrum have subscriber bases that are increasingly generating data traffic in addition to high, legacy voice demand. Network capacity based on these smaller spectrum amounts will be rapidly exhausted as these providers increase their subscriber base and as their subscribers consume more data. For example, there are at least three major commercial wireless broadband providers in Philadelphia, and two in San Diego, with less than 50 MHz.[42] All providers will need more spectrum to offer competitive wireless broadband services.

- If there are to be new entrants in the industry, they will also need spectrum.

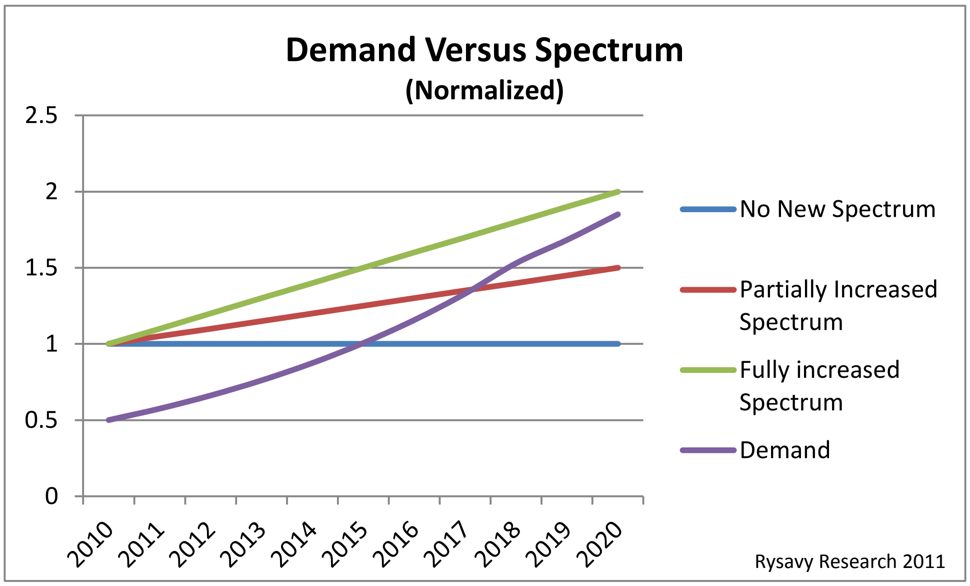
The need for new spectrum is no different when looking at individual operators or the industry as a whole. One way to assess the benefit of new spectrum is to compare the total demand for spectrum across the industry relative to capacity, as shown in Figure 4, which normalizes capacity and spectrum to a value of 1 in 2010. In 2010, the figure shows demand at about half of capacity. The figure depicts

[41] Assumption: as much data offloaded as carried on the LTE network.

[42] Source: FCC, "Spectrum Dashboard," http://reboot.fcc.gov/spectrumdashboard/searchMap.seam.

demand increasing at a fairly rapid rate through 2017 then slowing down thereafter. If no new spectrum becomes available, demand will likely exceed capacity within four years in high-traffic markets. "Partially increased" spectrum is based on a 50% increase of spectrum relative to currently available amounts by 2020. But in this scenario, demand still exceeds capacity within this decade. Fully increased spectrum is based on an approximate 100% increase in spectrum by 2020, as intended by the FCC's National Broadband Plan and the President's Memorandum. It is only through this aggressive allocation of spectrum that demand can possibly be met. Even with this substantial added spectrum, the figure assumes that operators deploy aggressive offload and small-cell architectures, such as femtocells and picocells.

Figure 4: Demand Versus Different Spectrum Scenarios



Clearly, additional spectrum contributes directly to increasing capacity. But what does it mean for consumers and U.S. innovation if this spectrum is not made available?

Adverse Application Effects

The effects of insufficient spectrum are multiple and all negative. One immediate effect is network congestion. Too many users competing for too few network resources cause congestion. This leads to a variety of significant adverse effects in terms of the functionality of the mobile Internet for consumers, including:

- Sluggish behavior (e.g., slow-loading Web pages)
- Stalls (e.g., failures of streaming video like remote health monitoring)
- Complete failure (application or computer system has to be restarted)
- Communications protocols behave erratically (e.g., undelivered packets of data)
- Unpredictable application behavior (e.g. works some times and not others)

Sluggish behavior is easy to understand by taking some typical network configurations and looking at different numbers of users simultaneously loading Web pages. A typical Web page today is over 1 MB in size. Assuming a 1 MB size, Figure 5 shows how page load time increases with higher numbers of simultaneous users. A page load time of greater than 10 seconds represents "sluggish" behavior. For example, this occurs with about 15 users simultaneously accessing Web pages in a 2-HSPA carrier scenario and with about 20 users in an LTE scenario. Doctors in San Diego might be in the office with their wireless tablet trying to access a patient's vital statistics or medical history using the Medical Information Anytime Anywhere application developed by Palomar Pomerado Health officials.[43] In Philadelphia, practitioners might be earning continuing medical education credits through their MedPageToday Mobile application, which contains articles peer-reviewed under the direction of the University of Pennsylvania School of Medicine.[44] Students at the University of California, San Diego may be accessing information about courses or listening to podcasts of prior lectures using the school's iPhone app.[45] A Phillies fan might be trying to order food and drinks at Citizens Bank Park using the At Bat 2010 application.[46] Slow page update times will frustrate these users, and drive them away from these applications and other innovative offerings.

Greater capacity will minimize such sluggish performance. This is not, however, a one-time adjustment. Operators will need to continually augment capacity to address escalating demand.

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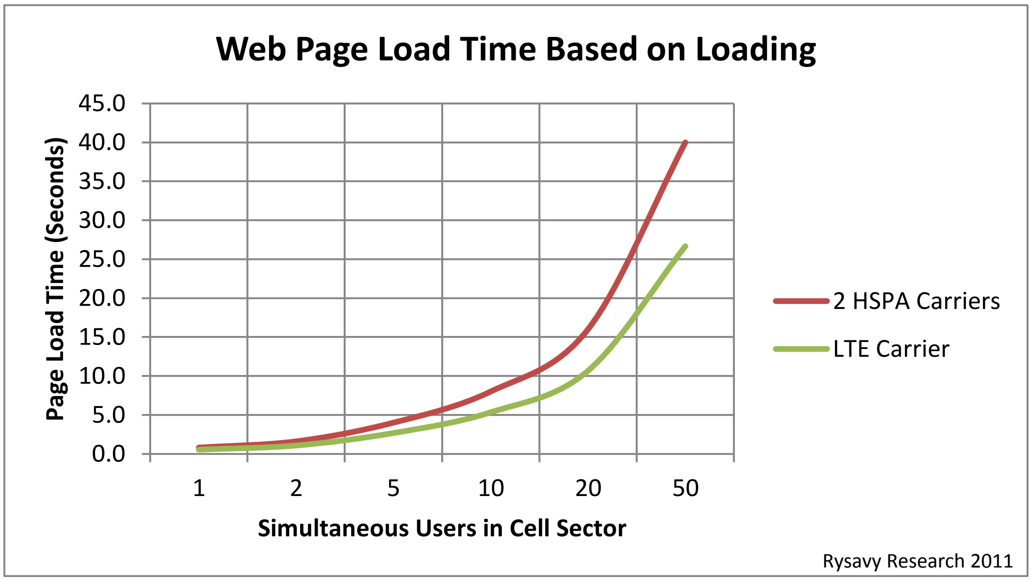
[43] Source: Janet Lavelle, "Wireless Application Would Give Doctors Access to Real-time Records," SAN DIEGO UNION-TRIBUNE, Feb. 20, 2011, http://www.signonsandiego.com/news/2011/feb/20/wireless-device-would-give-doctors-access-real-tim/#.

[44] Source: MedPageToday.com, http://www.medpagetoday.com/iPhone_promo.cfm (last visited Jan. 27, 2011).

[45] Source: Dian Schaffhauser, "UC San Diego Offers Free iPhone App," *CAMPUS TECH.,* June 25, 2009, http://campustechnology.com/articles/2009/06/25/uc-san-diego-offers-free-iphone-app.aspx.

[46] Source: MLB.com, "MLBAM, Philadelphia Phillies & Aramark join to debut Mobile Food Ordering App at Citizens Bank Park" (Sept. 23, 2010), http://mlb.mlb.com/news/press_releases/press_release.jsp?ymd=20100923&content_id=14992180&vkey=pr_mlbcom&fext=.jsp&c_id=mlb.

Figure 5: Web Page Load Times for Typical Web Pages



Beyond sluggish performance, there is also the risk that networks that have insufficient capacity (due to insufficient spectrum) have to significantly delay or ultimately drop packets. Packets arrive at a base station or other radio-access network infrastructure node over a high speed connection such as fiber. The base station then transmits the packets over the slower radio connection. If there are too many incoming packets the result will be packets being dropped or significantly delayed. This is an inevitable consequence when there is greater demand than capacity. It is the equivalent of a clogged freeway on-ramp during rush hour. It does not reflect any improper design or management by the operator but a simple overwhelming of the system as it exists today.

In addition to slower performance, outright application failures would become more widespread and commonplace. Most communications protocols implement timeouts on their operations, including Transmission Control Protocol (TCP) itself, the fundamental packet-transport protocol used in the Internet. With large delays or dropped packets, communications protocols will attempt to deliver data reliably. But at some stage of congestion, they can no longer cope properly. At that point, applications will either indicate a failure, or worse, terminate the application and require a full-system restart. This means a user could be in the midst of booking a flight and suddenly they lose their entire session. Or students could be taking exams and lose all of their data.

The worst problem with congestion is that it is unpredictable. A lightly loaded network will function fine, but with more users getting on the network, applications will become unreliable. This "on-again, off-again" mode of operation is frustrating for users, who would grow dissatisfied with the service. When people depend on service, they find it stressful when they cannot rely on it and may well abandon the service if it proves unstable.

Market Effects

Many service providers, like those in Philadelphia and San Diego, lack the spectrum capacity to meet the rising data demand and will increasingly become capacity constrained as more and more users adopt mobile broadband devices. The resulting effects of congestion will not be isolated to specific industries; rather they will have widely felt adverse effects across finance, telemedicine, education, social networking, research, machine-to-machine connectivity, online gaming and entertainment.[47] Without additional spectrum, an operator's response to congestion can either be to allow it to happen or to implement pricing or other schemes that limit demand.[48] For example, usage caps can limit how much data users consume. In today's market, users can consume a modest amount of streaming content, but they may be reluctant to use a mobile-broadband connection as a substitute for a fixed connection. Users who find the limits to be insufficient to conduct the tasks they want will become frustrated. Higher monthly bills could cause consumers to grow dissatisfied and potentially stop using the service. Moreover, when usage limits are so restrictive that users are uncertain about what they can do or cannot do, they typically opt to do nothing. All of this greatly diminishes the value and appeal of mobile connectivity.

Ultimately, congestion will have a significantly negative effect on the wireless market. Consumers will use the service less.[49] Minorities and lower income groups that increasingly rely only on wireless to access the Internet will be particularly affected by approaches that could limit demand including usage caps, higher pricing and other tools that place a heavy emphasis on data offload, which requires an

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[47] Source: Coleman Bazelon, "The Need for Additional Spectrum for Wireless Broadband: The Economic Benefits and Costs of Reallocations," Oct. 23, 2009, at 22 ("Broadband connectivity has measurable impacts on output of the entire economy, well beyond the telecommunications sector.").

[48] Source: Swarup Mandal, Debashis Saha, & Mainak Chatterjee, *Dynamic Price Discovering Models for Differentiated Wireless Services*, 1 J. COMM. 50 (2006) ("[S]ervice providers use pricing as a tool to resolve this constraint on the bandwidth."); Andrew Seybold, "Data Congestion and New Pricing Models," AndrewSeybold.com (June 10, 2010) (stating that while carriers are making technological improvements to increase bandwidth capacity, they still need to "use all of the technology tools that are available along with management tools including pricing."), http://andrewseybold.com/1635-data-congestion-and-new-pricing-models; Aaron Blazar, "AT&T Wireless Data Pricing Changes Analysis," Atlantic-ACM (June 11, 2010) ("Although traffic management efforts have logged some success, the continued growth of usage, and increased penetration of smartphone devices, is driving carriers to reevaluate data plan pricing in efforts to reshape end-user behavior."), http://www.atlantic-acm.com/index.php?option=com_content&view=article&id=534:dataline-06-10-10&catid=7:datalines&Itemid=5.

[49] Source: FCC, "Connecting America, The National Broadband Plan," March 2010, at 77 ("[S]carcity of mobile broadband could mean higher prices, poor service quality, an inability for the U.S. to compete internationally, depressed demand and, ultimately, a drag on innovation.").

underlying wireline broadband subscription.[50] This will be especially true in urban areas where there are a higher percentage of minorities and people living below the poverty level than the national average. Lower usage also will detract from the investment case across the wireless sector, curbing the growth potential of application developers, mobile device vendors, service providers and operators.[51]

Conclusion

With exponentially increasing consumer demand, today's mobile broadband market is surging ahead. But the progress is advancing so rapidly that it threatens to quickly exceed the capacity of today's wireless networks. Operators have several methods available to augment capacity, such as increasing the number of cell sites, offloading onto other networks and deploying more efficient technologies. These measures, however, are not sufficient to meet growing market demand. The only viable solution is to allocate more spectrum for these services. More spectrum will allow operators to continue to meet exploding consumer demand, enable new services, and bring even more competition to the market.

Without additional spectrum, technical and market effects will be calamitous. Networks in cities, like Philadelphia and San Diego, will become congested with applications behaving unreliably and erratically. Operators may have no choice but to try to limit demand. As a result, promising advances, like the innovative mobile applications already available to consumers, may not reach the marketplace, investment levels will drop, and the market will not realize its full potential. The U.S. will face the real possibility of losing its global leadership position in this crucially important segment of the economy.

Mobile broadband is not a market unto itself. Rather, it is the intersection of the leading edges of computing, Internet technology and communications technology. Mobile innovation in this country has thrived in an environment of minimal government intervention. But, today, government leadership is urgently needed to make additional spectrum available to power the next wave of connected innovation and growth. Nurturing and expanding this dynamic sector is of vital, strategic importance to this nation.

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[50] Both femtocells and Wi-Fi offload assume a fixed-Internet connection for transporting data to the Internet.

[51] Source: Gerald R. Faulhaber & David J. Farber, *Innovation in the Wireless Ecosystem: A Customer-Centric Framework*, 4 INT'L J. COMM. 73, 82 (2010) ("Customers demand access to the Internet and other data services, so Internet applications are developed, devices become Internet-enabled, and core networks ensure that capacity is available for highspeed data through spectral efficiency innovation. All of this innovation is driven by customer demand; it is *customer-centric innovation.*"); Fairview Capital, "Wireless Innovation: Bridging the Mobility Gap; Industry Overview from a Venture Capital Perspective," (noting that consumer demand for mobile wireless is driving investment in new devices, applications, advertising, mobile payment services, gaming, and infrastructure development), http://www.fairviewcapital.com/images/IndustryReport_Wireless.jpg.

ATTACHMENT B

ANALYSIS GROUP
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Private Sector Investment and Employment Impacts of Reassigning Spectrum to Mobile Broadband in the United States

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EXECUTIVE SUMMARY

Mobile broadband is critical to the U.S. communications infrastructure and our future economy. Private sector investment, with substantial job creation benefits, can be facilitated by the reassignment of spectrum to mobile broadband. Building on previous studies, we estimate that the reassignment of 300 MHz of spectrum to mobile broadband within five years will spur $75 billion in new capital spending, creating more than 300,000 jobs and $230 billion in additional Gross Domestic Product (GDP). The release of an additional 200 MHz of new spectrum after five years will create an additional 200,000 jobs and increase GDP by an additional $155 billion. These estimates represent the tip of the iceberg in terms of economic benefits. Reassigning additional spectrum to mobile broadband also would generate substantial spillover effects as companies such as Apple, Google and Qualcomm, small application developers and other innovative start-up companies rush to create new mobile broadband products and services. Given published estimates of the spillover effects from communications and broadband investment, it seems likely that the spillover effects from the reassignment of spectrum to mobile broadband will exceed, by a considerable margin, the multiplier effects that we present here. A delay in the reassignment of spectrum will necessarily delay the consequent job and economic output benefits that we identify.

1. INTRODUCTION

Background

Mobile broadband is emerging as a critical feature of the U.S. communications infrastructure and essential to the future of our economy. Capital spending by companies in the wireless sector has been substantial over the past decade and has laid a solid foundation of modern connected infrastructure that has contributed significantly to economic growth and job creation throughout the United States. Between 2002 and 2010, capital spending in the wireless industry exceeded $185 billion,[1] creating, on average, approximately 420,000 jobs throughout the economy.[2] In the current stagnant economic environment, policymakers should be concerned with facilitating private sector investment, which will generate market-based growth and job creation. Stimulating investment in mobile broadband infrastructure will create jobs, spur consumer demand and facilitate the innovation of new goods and services.

Wireless spectrum is an essential input to mobile broadband services and there is widespread agreement that spectrum constraints are challenging for the industry. For example, U.S. networks are currently operating at 80 percent of capacity, well above the aggregate utilization rate of 65 percent for all countries worldwide.[3] Acknowledging that mobile broadband is "a key platform for innovation in the United States over the next decade,"[4] the Federal Communications Commission (FCC) has expressed concern that "[t]he growth of wireless broadband will be constrained if government does not make [additional] spectrum available… If the U.S. does not address this situation promptly, scarcity of mobile broadband could mean higher prices, poor service quality, an inability for the U.S. to compete internationally, depressed demand and, ultimately, a drag on innovation."[5] As a remedy for this problem, the FCC has proposed to make 500 MHz available for mobile broadband use over the next ten years, including 300 MHz in the next five years. Experts have estimated that between two and four times this amount will be needed by 2020 to continue supporting consumer demands.[6] In helping to reallocate spectrum to meet evolving consumer demand, policymakers have a unique opportunity to facilitate private sector investment in critical wireless infrastructure that will create jobs, spur demand and encourage innovation.

Building on past studies of the economic impact of investment in communications infrastructure, updated with current data, we estimate the likely macroeconomic effect of investment by the wireless industry to build out the spectrum release proposed by the FCC.[7] We find that the build out of 300 MHz of new

[1] Robert F. Roche and Liz Dale, "Wireless Investment and Build-Out Report," CTIA Public Affairs (May 2011), Table 7.
[2] Job creation estimate based on CTIA investment figures and BEA 2010 employment multiplier described below.
[3] Credit Suisse, "Global Telecom Equipment: Global Wireless Capex Survey," (July 2011).
[4] National Broadband Plan, Federal Communications Commission, Chapter 5, p. 75.
[5] Ibid, p. 77.
[6] "The ITU released an analysis in 2006 predicting that the total amount of spectrum needed to support mobile broadband in developed countries like the U.S. would be 1,300 megahertz by 2015 and up to 1,720 megahertz by 2020." National Broadband Plan, Federal Communications Commission, Chapter 5, p. 84.
[7] See, e.g.: Thomas W. Hazlett, Coleman Bazelon, John Rutledge and Deborah Allen Hewitt, "Sending the Right Signals: Promoting Competition through Telecommunications Reform" U.S. Chamber of Commerce (September 2004); Crandall, Robert, William Lehr and Robert Litan, "The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data," *Issues in Economic Policy* (2007); Jeffrey A. Eisenach, Hal J. Singer and Jeffrey D. West, "Economic Effects of Tax Incentives for Broadband Infrastructure Deployment," Fiber-to-the-Home Council (2009); Charles Davidson and Bret Swanson, "Net Neutrality, Investment & Jobs: Assessing the Potential Impacts of the FCC's Proposed Net Neutrality Rules on the Broadband Ecosystem," Advanced Communications Law & Policy Institute at New York Law School (June 2010); T. Randolph Beard, George S. Ford, and Hyeongwoo Kim, "Jobs, Jobs, Jobs: Communications Policy and Employment

spectrum made available for commercial mobile broadband uses will create more than 300,000 new jobs and an additional $230 billion in GDP over five years, accounting for direct, indirect and induced effects. In addition, we estimate that the long-run impact of ongoing maintenance and upgrade capital spending associated with the newly deployed spectrum will be almost 340,000 new jobs and a $50 billion annual increase in GDP. The follow-on release of an additional 200 MHz of new spectrum within 10 years will create more than 200,000 new jobs and increase GDP by an additional $154 billion.

These estimates are likely just the tip of the iceberg in terms of long-term economic benefits of reassigning spectrum to mobile broadband. The FCC has identified mobile broadband as a "transformative" technology that is likely to yield more economic benefits, in terms of new and innovative products and services, than internet computing or mobile voice communications. The additional spectrum will foster innovation, not only by wireless carriers, but also by companies such as Apple, Intel, Google, Qualcomm, and countless small mobile application developers and start-up companies. The additional spectrum also will facilitate increased broadband penetration. One recent study estimated that each one percent increase in broadband penetration creates approximately 300,000 jobs.[8]

Our study demonstrates the substantial benefits to the U.S. economy – in terms of job creation, GDP gains and opportunities for innovation – from spectrum reassignment. Any delay in the reassignment of spectrum to mobile broadband would necessarily delay the realization of these benefits because there would be less private sector investment, fewer new jobs created and lower overall economic output.

Methodology

We estimate the likely impacts on total employment and on GDP of incremental investment by the wireless industry to build out the FCC's proposal to make 300 MHz of additional spectrum available to commercial providers of mobile broadband within five years. We also consider the impact of an additional 200 MHz in 10 years, as proposed by the FCC. Based on our estimates of capital spending that is likely to result from the availability of additional spectrum and using data from the U.S. Bureau of Economic Analysis (BEA), we estimate the associated increase in employment and GDP from three economic effects:

- Direct Effects: Direct effects include the impacts on employment and output as a result of the initial investments made by companies acquiring direct access (via winning auction bids) to the newly available spectrum.

- Indirect Effects: Indirect effects include the employment and output impacts on other firms, such as vendors, from purchases made by the companies who are making investments as a result of their acquisition of newly available spectrum.

Effects in the Information Sector," Phoenix Center Policy Bulletin No. 25, Phoenix Center for Advanced Legal and Economic Public Policy Studies (October 2010); Crandall, Robert W. and Hal J. Singer, "The Economic Impact of Broadband Investment," Broadband for America (February 2010).

[8] Crandall, Lehr and Litan (2007).

- Induced Effects: Induced economic impacts are generated by expenditures made by employees of the firms that benefit from the direct and indirect effects. Because consumer spending accounts for approximately 70 percent of GDP, it is important to include an estimate of the induced impact to evaluate overall economic impact.

2. PRIVATE SECTOR CAPITAL SPENDING STIMULATED BY SPECTRUM REASSIGNMENT

Beginning in 1994, the FCC auctioned PCS licenses for 120 MHz of spectrum for mobile telephony. Hazlett et. al. (2004) estimate that in the five years from 1994 to 1998 the wireless industry invested $33.8 billion to build out PCS networks.[9]

To project the effects of making an additional 300 MHz of bandwidth available to service providers today, we assume an increase in capital spending (in 2010 dollars) proportional to the investment that occurred following PCS licensing, adjusting for the current proposal to issue licenses for 300 MHz relative to the 120 MHz of spectrum allocated to PCS. Our estimates of additional investment that will result from build-out and deployment of newly available spectrum are derived from incremental capital investment data as reported by the wireless industry and exclude the cost of acquiring spectrum via auction.[10] These estimates of capital spending increase over time, consistent with the observed ramp-up in capital spending during the build out of the PCS spectrum. As reported in Table 1, we estimate that an additional $75.3 billion of capital spending over a five-year period will be required to build out mobile broadband networks using 300 MHz of reassigned spectrum.[11]

[9] Hazlett et. al. (2004), p. 103.
[10] Roche and Dale (2011), pp. 21 and 38, Tables 6 and 7.
[11] Because not all 120 MHz of PCS spectrum was deployed during the period 1994-1998, our estimate of build out costs likely is conservative. It also reflects a reasonable balance between deployment of reallocated spectrum by incumbent carriers and by greenfield developers, who likely will experience higher capital spending than PCS carriers because of more stringent environmental review processes and greater siting challenges currently than at the time of the PCS build out.

Table 1: 5-Year Impact of Spectrum Reassignment on Capital Spending ($ millions)

A. Prior to PCS Auctions		1991	1992	1993	Average		Notes/Sources
[1]	1991-1993 Capital Spending	$2,389	$2,590	$2,694	$2,558		CTIA's Wireless Industry Investment and Build-Out Report (May 2011), p. 21, Table 6.
[2]	PPI Deflator (to 2010 Dollars)	0.948	0.933	0.921			PPI for Broadcast and Wireless Communications Equipment industry from Bureau of Labor Statistics (http://www.bls.gov/ppi/#data). 2010 PPI divided by PPI for 1991-1993.
[3]	1991-1993 Capital Spending in 2010 Dollars (as Adjusted by PPI Deflator)	$2,265	$2,417	$2,482	$2,388		= [1] x [2].
B. Capital Spending, 1994-1998		1994	1995	1996	1997	1998	
[4]	1994-1998 Capital Spending	$4,982	$5,141	$8,493	$13,484	$14,484	CTIA's Wireless Industry Investment and Build-Out Report (May 2011), p. 21, Table 6.
[5]	PPI Deflator (to 2010 Dollars)	0.912	0.916	0.910	0.897	0.899	PPI for Broadcast and Wireless Communications Equipment industry from Bureau of Labor Statistics (http://www.bls.gov/ppi/#data). 2010 PPI divided by PPI for 1994-1998.
[6]	1994-1998 Capital Spending in 2010 Dollars (as Adjusted by PPI Deflator)	$4,546	$4,709	$7,727	$12,094	$13,015	= [4] x [5].
C. Additional Capital Spending, 1994-1998 (in 2010 Dollars)							
[7]	1991-1993 PPI Adjusted Average (prior to PCS auctions)	$2,388	$2,388	$2,388	$2,388	$2,388	From [3].
[8]	PCS Capital Spending in 2010 Dollars (120 MHz)	$2,158	$2,321	$5,339	$9,706	$10,627	= [6] - [7]. Hazlett et al. (2004) estimate capital costs for buildout of 120 MHz of PCS spectrum over 5 years.
[9]	Build out Capital Spending per 100 MHz (2010 dollars)	$1,798	$1,934	$4,449	$8,088	$8,856	= [8] x 100/120.
D. Capital Spending, Years 1 - 5 (300 MHz)		Year 1	Year 2	Year 3	Year 4	Year 5	
[10]	Build out Capital Spending for 300 MHz	$5,395	$5,803	$13,348	$24,264	$26,568	= [9] x 3

3. THE IMPACT OF ADDITIONAL CAPITAL SPENDING

In the current stagnant economic environment, the U.S. economy has unused resources, including capital that is available for investment but has not been deployed, and unemployed workers. We know from fundamental economic theory that increasing purchases in one sector will cause an economic "ripple effect." In this case, increased capital spending by mobile broadband service providers will cause increases in spending by direct suppliers to the industry and by suppliers' suppliers. Moreover, newly created jobs and additional economic output generate more consumer spending, and this new spending creates yet more jobs and economic output. This is the multiplier effect described in macroeconomics textbooks. As we explain below, U.S. Bureau of Economic Analysis (BEA) multipliers, for example, suggest that each additional $1 of telecom capital spending leads to $3.08 in extra output, while every $1 million rise in telecom capital spending leads to more than 20 new jobs.

Based on the FCC's proposal and historic data, we estimate incremental investment by the wireless sector and the associated impact throughout the U.S. economy in terms of increased employment and GDP of building out and integrating the reassigned spectrum. As described above, additional spillover effects from the increased availability of spectrum are likely to be very large. Below, we describe in more detail our estimates of additional capital investment to quantify economic impacts on employment and GDP using multipliers from the BEA, Regional Economic Input-Output Modeling System (RIMS II).

The government measures these multipliers for each sector, so that we can calculate the effect of each dollar of capital spending on the rest of the economy.

Employment

We can expect job creation as a consequence of new capital investment in the deployment of mobile broadband. Several authors have examined the expected impact of investment in wireless and mobile broadband using BEA Type II RIMS multipliers for "Final-demand employment"[12] for the construction and communications equipment sectors.[13] These RIMS II multipliers incorporate direct, indirect and induced employment impacts. A recent study by Credit Suisse reported that between 2002 and 2010 the average share of capital spending on equipment relative to total capital spending by wireless carriers was 44 percent.[14] We estimate the employment impacts of the capital spending shown in Table 1. Applying this approach to current data, we calculate a weighted average of Construction (56%) and Broadcasting and Communications Equipment (44%) Type II multipliers (20.4 jobs for every $1 million invested). We estimate that private sector capital spending associated with the build out and development of 300 MHz of spectrum for mobile broadband will generate an average of more than 300,000 jobs throughout the economy over five years. See Table 2.

Economic Output

We also estimate the increase in GDP from the incremental capital investment described above using RIMS II multipliers obtained from the BEA. We find that capital investments stimulated by newly released spectrum will increase GDP significantly. The reassignment of 300 MHz will increase GDP by $16.6 billion in the first year of the five-year period, rising to an $81.8 billion annual increase by the final year. Over the five-year period, we estimate a total impact on domestic output of more than $230 billion. This result will require no contribution by the U.S. Treasury and is likely just the tip of the iceberg, in terms of economic benefits. See Table 2.

[12] RIMS II Online Order and Delivery System <https://www.bea.gov/regional/rims/rimsii/help.aspx>.
[13] See e.g., Hazlett et. al. (2004); Eisenach, Singer and West (2009); Crandall and Singer, (2010); Beard, Ford and Kim (2010).
[14] Credit Suisse (2011).

Table 2: Five-Year Impact of Spectrum Reassignment on GDP and Employment

	Multiplier	Year 1	Year 2	Year 3	Year 4	Year 5	Years 1 - 5 Total	Years 1 - 5 Average
Build out Capital Spending ($ million)		$5,395	$5,803	$13,348	$24,264	$26,568	$75,377	$15,075
Change in GDP Output ($ million)	3.0792	$16,612	$17,868	$41,101	$74,716	$81,810	$232,106	$46,421
Change in Employment (number of jobs)	20.4053	110,080	118,405	272,362	495,120	542,129	n/a	307,619

Notes/Sources:

1/ Output and employment multipliers from US Bureau of Economic Analysis, Regional Input-Output Modeling System (RIMS II), 2002 U.S. Benchmark Input-Output data and 2008 Regional Data Multipliers for 48 Contiguous States (Requested on 7/6/2011). Final-demand multipliers used are weighted average of *Construction* (56%) and *Broadcasting and Communications Equipment* (44%) Type II multipliers. See average equipment to capital expenditures ratio 2002 - 2010 from "Global Wireless Capex Survey - A multi-year spending cycle," Credit Suisse, July 2011 at 8 ; Robert W. Crandall and Hal J. Singer, "The Economic Impact of Broadband Investment" (2010) at 25-26.

2/ Build out capital spending estimated based on CTIA's Wireless Industry and Investment Build-Out Report (May 2011), p. 21, Table 6; Hazlett et al., "Sending the Right Signals: Promoting Competition Through Telecommunications Reform," A Report to the U.S. Chamber of Commerce, September 22, 2004, p. 103. Capital spending estimates following mid-1990s PCS licensing, adjusted by Producer Price Index for Broadcast and Wireless Communications industry (BLS).

The Effects of Ongoing Maintenance and Upgrade Capital Spending

Established wireless networks require continuous capital spending on maintenance (e.g., replacement equipment and spares) and upgrade equipment (e.g., current carrier upgrades to fourth generation networks or 4G). One important economic contribution of the FCC's spectrum proposal is that it will generate economic benefits not only during the build out period, as we have described above, but also over the long run as additional capital is invested in maintenance and network upgrades. We estimate required maintenance and upgrade capital spending based on reported capital spending in the period 2002–2004. By 2002, the wireless industry had deployed most of the PCS spectrum, with the notable exception of the licenses held by NextWave. Uncertainty regarding the NextWave licenses was ultimately resolved in 2004, and in later years the FCC auctioned off additional spectrum for mobile services. Assuming that capital spending during the period 2002–2004 was predominantly for maintenance and upgrades, as opposed to the deployment of new spectrum, we interpret average annual capital spending during this period of $16.5 billion as a reasonable estimate of long-run maintenance and upgrade capital spending for the 300 MHz of spectrum the FCC is currently proposing to reassign. Based on the multiplier approach described above, we estimate that additional annual capital spending of $16.5 billion would generate an additional $50 billion in GDP annually and more than 330,000 new jobs.

The FCC's Proposal to Reassign an Additional 200 MHz

In the 2010 Broadband Plan, the FCC proposed reassigning a total of 500 MHz to mobile broadband over 10 years. We have described in detail the impact of reassigning 300 MHz within five years as the FCC proposed. The additional 200 MHz of spectrum that the FCC proposes to reassign to mobile broadband also would stimulate considerable capital spending, with consequent benefits for employment and GDP.

Based on our analysis of capital spending associated with the PCS spectrum, we estimate that an additional 200 MHz of spectrum would stimulate approximately $50 billion in capital spending to deploy the spectrum for the provision of mobile broadband over a five-year period subsequent to the reassignment of 300 MHz of spectrum discussed above. This additional capital spending would generate an additional $155 billion in GDP and create an average of more than 200,000 jobs over a five-year build out period, based on the employment and output multipliers described above.

4. SPILLOVER EFFECTS

Our estimates of employment and GDP gains from investment to develop 300 MHz of additional spectrum are only one component of total economic benefits. We do not account for spillover effects from new mobile broadband goods and services. The multiplier effects we have described capture the impact additional investment in new spectrum will have on the U.S. economy, based on measurements of actual relationships between sectors of the economy. In other words, the model captures the effect on economic output (GDP) and employment for products and services that already exist. However, the additional spectrum will also have important positive effects on innovation and the development of new goods and services. Deployment of the new spectrum will facilitate the development of goods and services that are currently in development, such as new software applications, new mobile devices and new healthcare applications. Additional spectrum for mobile broadband will also spur the development and commercialization of new products and services that may be difficult for most of us to imagine at the present. These new wireless products and services likely will change the way people work and play, change economic relationships, lead to productivity gains and ultimately boost employment and GDP. The effect that investment has on productivity, innovation and the commercialization of new products is typically called the spillover effect. Because spillover effects are the consequence of economic relationships that don't exist at the present, it's very difficult to project the size of these effects. Several economists have studied historic spillover effects associated with investments in information technology and telecommunications infrastructure. For example, Crandall, Lehr and Litan (2007) estimate that a one percent increase in broadband penetration would generate approximately 300,000 new jobs.[15] In addition, Jorgenson, Ho, and Stiroh (2008) report that one-third of the growth in labor productivity from 2000 to 2006 can be attributed to information technology and telecommunications.[16] Given documented economic impacts of spillover effects, it seems likely that the spillover effects from the reassignment of 300 MHz of spectrum to mobile broadband will exceed, by a considerable margin, the multiplier effects that we present here.

5. CONCLUSION

As the FCC has concluded, mobile broadband is a critical platform for future innovation. The U.S. wireless industry currently faces severe spectrum constraints, limiting the ability of companies to develop new mobile broadband products and services. By facilitating the reallocation of underutilized spectrum,

[15] Crandall, Lehr and Litan (2007).
[16] Jorgenson, Dale, Mun Ho, and Kevin Stiroh, "A Retrospective Look at the U.S. Productivity Growth Resurgence," *Journal of Economic Perspectives*, Volume 22, Number 1 (2008) pp. 3-24.

policymakers can create a favorable environment for private sector investment in critical wireless infrastructure that will create jobs, spur demand and encourage innovation. However, the economic impacts from capital spending to build out additional spectrum for mobile broadband, which we report in this paper, represent only the tip of the iceberg in terms of long-run economic benefits. A more extensive and robust mobile broadband network will generate considerable spillover effects as firms create new and innovative products and services. The sooner that spectrum is reassigned to mobile broadband, the sooner investment capital will be deployed. A delay in the reassignment will mean a delay in private sector investment and job creation.

ATTACHMENT C

INTERNATIONAL COMPARISONS: THE HANDSET REPLACEMENT CYCLE

By Roger Entner, Analyst and Founder, Recon Analytics

The United States still suffers from a wireless inferiority complex. Seemingly every other country is better. In fact, the further away the country the better it seems. Is this inferiority complex based on facts? Or are American wireless consumers victims of a complex delusion?

This is the first in a series of reports from Recon Analytics in conjunction with Mobile Future that will examine, compare and contrast the performance of 14 countries: Brazil, Canada, Finland, France, Germany, India, Israel, Japan, Korea, Mexico, South Africa, the United Kingdom, and the United States. The countries were selected to provide a good comparison in terms of geographic and economic diversity as well as the different stages of wireless development, in terms of wireless penetration and wireless data usage.

Mobile device sales figures are among the most obscure and difficult to obtain statistics around the wireless world. Recon Analytics has worked with handset manufacturers to ascertain the number of devices sold in each country. We use these figures to then calculate the handset replacement cycle (i.e., how often a consumer replaces their device). Mobile handsets are becoming more capable every year, while price points for these devices have held steady. Shorter handset replacement cycles translate into newer, more technically advanced devices in the hands of consumers and business users. The more technically advanced the device, the more likely a consumer or business user is to take advantage of advanced wireless services and mobile applications. This is a critical prerequisite for innovation that every country needs to succeed and prosper the 21st century. The innovation in mobile devices and its associated services has been impressive and unprecedented. New smartphones in conjunction with high-speed wireless data networks have truly put the power of the Internet in the palm of people's hands. The things people do and the utility and satisfaction they receive were inconceivable only five years ago. Access to private and business email anywhere, anytime is no longer viewed as a miracle. Watching the same on-demand television programs that consumers have at home is now taken for granted. And on the spot, real-time information about business processes has transformed into a necessity rather than the mere academic vision statement and wishful thinking it once was.

Through this explosion in capabilities, these new devices engage owners much more than any device they might have had in the past. Unsurprisingly, every survey confirms that consumers with a new, more powerful device have higher satisfaction scores than consumers with older, less capable devices.

Table 1

Handset Replacement Cycle in Months

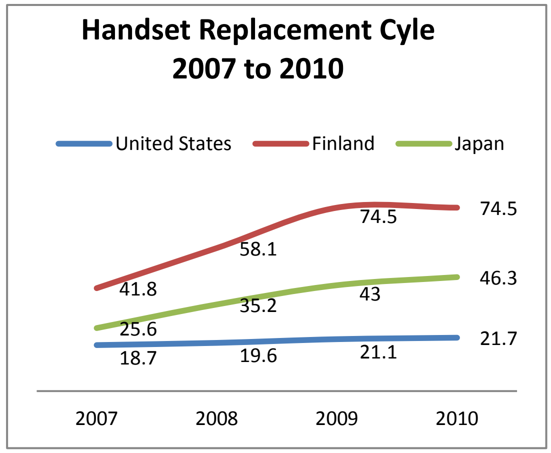
	2007	2008	2009	2010	Prepaid Subscriber	Income in PPP$
Brazil	51.5	74.2	70.4	80.8	80%	$11,239
Canada	29.5	30.8	31.8	33.0	20%	$39,057
Finland	41.8	58.1	74.5	74.5	14%	$34,585
France	28.5	28.8	29.9	30.8	30%	$34,077
Germany	43.7	55.8	49.5	45.7	55%	$36,033
India	322.1	144.0	185.6	93.6	96%	$3,339
Israel	67.1	56.1	67.0	76.5	53%	$29,531
Italy	53.3	43.1	42.9	51.5	87%	$29,392
Japan	25.6	35.2	43.0	46.3	1%	$33,805
Korea	27.3	25.1	24.2	26.9	0%	$29,836
Mexico	48.6	41.7	42.9	39.6	86%	$14,430
South Africa	52.3	118.6	46.3	38.2	80%	$10,498
United Kingdom	24.5	24.4	26.4	22.4	54%	$34,920
United States	18.7	19.6	21.1	21.7	22%	$47,284

Source: Recon Analytics, 2011, IMF 2010

The data set in Table 1 shows that the United States has consistently had the shortest handset replacement cycle, while India and Brazil have the longest. In 2010, Americans replaced their mobile device after one year and nine months, whereas Indians replaced their device after seven years and nine months and Brazilians after six years and eight months. The considerably slower pace of technological change in the most vibrant technology sector is truly amazing. Many countries in Europe, which American folklore considers leaders in wireless, are actually laggards. Average Germans and Italians keep their devices in excess of four years, more than twice as long as Americans. This proves conclusively that Americans use the newest handsets in the world. As we all know, new affordable handsets are a key decision factor for consumer when chosing their mobile carrier. Hence the level of handset subsidization is an indicator of how competitive a market is. In no other country are consumers upgrading faster than in the U.S., so no one else has comparable access to the latest handsets, technology and services than the American consumer. The rapid handset replacement cycle has put new smartphones in more people’s hands faster than anywhere else in the world. As a direct result the mobile applications market is sky rocketing. Apple’s App Store alone had 1 billion application downloads within nine months of its launch and hit the 10 billion download mark in just two and a half years from more than 350,000 applications.

There are a number of other points the table underscores.

The replacement cycle for the United States has edged up slightly since 2007. But, in comparison to Japan, which is often pointed to as an advanced wireless country, Americans upgrade far faster. In 2007, Japanese consumers replaced their handsets after slightly more than two and a half years, compared to the U.S. figure of 18 months. As noted, the U.S. figure has edged up, but the Japanese figure has nearly doubled to just under four years in 2010. A slow handset replacement cycle means that consumers and business cannot take advantage of new technologies as rapidly and adoption of those new technologies is correspondingly slow. This hinders new innovation and slows down the virtuous cycle in which the adoption of new technology creates new services, enhances efficiency and builds new revenue streams that help the overall economy of the country and its inhabitants. Even Finland, which is thought of as a wireless technology vanguard, has seen its handset replacement figures skyrocket from an already-sluggish 41.8 months in 2007 to 74.5 months. There's a good chance a consumer will replace their car faster than that.



What are the factors that get people to replace their handsets faster or slower? Let's look at some of the factors that could play a role.

- **Percentage of prepaid subscribers:** At first glance there seems to be a connection between the handset replacement cycle and the percentage of prepaid subscribers in a country. Many countries that have a slow handset replacement cycle have a high percentage of prepaid customers. Could it be that just being on prepaid means that you keep your handset longer? However, as a notable exception, it is obviously not stopping the people in the United Kingdom from changing their handsets almost as quickly as the people in the United States, even though they are more than twice as likely to be on prepaid plans.
- **Per capita income at purchase power parity:** Another factor could be simply how affluent the people are in a country undisturbed by exchange rates. The logic is that the more people earn the quicker people will replace their handset. The data in Table 1 generally agrees with that premise, but again there are important exceptions. Israelis, Italians, and Koreans earn almost the same, but the handset replacement cycle in Israel is 76.5 months, in Italy 51.9 months and in Korea 26.9 months. Although they have the same income level, Israelis keep their phone three times as long as Koreans, and Italians twice as long as Koreans. Is it because of prepaid subscriber levels? The data doesn't support that because Israel has 53% prepaid subscribers and Italy has 87% prepaid subscribers, while Korea has none.
- **Level of handset subsidization:** One common practice, especially among operators that provide their services via contract, is to subsidize the device in exchange for the commitment of the customer to stay a certain period with the operator. Similar to higher income, more affordable devices allow customers to purchase a device sooner rather than later. Instead of focusing on the absolute handset price, the handset subsidy is a better metric to consider because handset price overemphasizes low cost handsets regardless of

capabilities, whereas handset subsidy focuses on the shift in the value perception of the consumer. It is one thing to have a higher income and it's another to be tempted by a low price. Because data is sparse when it comes to average handset prices and even more so for how much an operator paid for a handset, we have to find a suitable proxy, ideally in the most vibrant part of the market – smart phones.

Fortunately, the Apple iPhone 4G with 16MB is such a proxy. Apple sold 18.65 million iPhones in Q1 2011 and achieved revenues of $12.3 billion from it, which results in an ASP of $660. The iPhone 4's ASP is higher than that of the iPhone 3GS, but the volumes for the iPhone 4 are vastly greater than for the iPhone 3GS. So for the sake of simplicity and conservativeness, let's make them even.

Table 2
Handset Subsidization: The iPhone 4G Case Study

	Operator	Unsubsidized iPhone Price in PPP$	Subsidized iPhone Price in PPP$	Handset subsidy in PPP$ off $660 ASP	Income in PPP$	2010 Handset Replacement Cycle
Brazil	Claro	n/a	$739	$67 profit	$11,239	80.8
Canada	Bell	$540	$131	$529	$39,057	33.0
Finland	Sonera	$871	$576	$84	$34,585	74.5
France	Orange	$710	$263	$379	$34,077	30.8
Germany	T-Mobile	$662	$187	$473	$36,033	45.7
India	n/a	n/a	n/a	n/a	$3,339	93.6
Israel	n/a	n/a	n/a	n/a	$29,531	76.5
Italy	TIM	$879	$309	$351	$29,392	51.5
Japan	Softbank	n/a	$104	$556	$33,805	46.3
Korea	SK	$724	$161	$499	$29,836	26.9
Mexico	Telcel	$1,233	$963	$303 profit	$14,430	39.6
South Africa	Vodacom	$n/a	$1,999	$1,309 profit	$10,498	38.2
United Kingdom	Orange	$797	$0	$660	$34,920	22.4
United States	AT&T	$599	$200	$460	$47,284	21.7

Source: Recon Analytics, Company information, 2011

Note: The iPhone is not offered in India and Israel and is only offered through an operator in Brazil, Japan, and South Africa. The iPhone in Canada is only offered with 3 year contracts.

One of the most interesting observations in the table above is that in the lowest income countries – Brazil, Mexico, and South Africa – the iPhone is sold at a profit. The iPhone in these countries is even more of a status symbol than it is in the United States and is simply unaffordable for the average consumer in that country. Therefore, the operators in these countries are following the rational path of charging for the iPhone as a luxury item to a largely price-insensitive clientele. This means that the market for the iPhone is vastly different compared to the other countries where it is a mass consumer item and does not make them suitable for our exercise.

Another interesting note is that Canada is the only country in the world that has three-year contracts for the purchase of a new device for the lowest price. For most devices the price difference between a 3 year contract and a 2 year contract is more than $300, sometimes even $400, whereas the difference between a 2 year, 1 year or no contract is only an additional $30 per step. This provides Canadians with a significant incentive to commit to 3 year contracts. Nevertheless, Canadians replace their devices every 2 ½ to 2 ¾ years. If a customer would like to upgrade their phone before the contract expired, they have to pay an additional Canadian-$20 per month until the original committed period expires to upgrade to the new device. Even with this additional cost, the average Canadian upgrades 6 to 9 months early. Even with the unique 3 year contracts, Canadians have the fourth shortest handset replacement cycle in the world. Clearly the contract length is not having a major impact compared to many other countries that have a longer handset replacement cycle (but shorter contract duration) than Canada.

What is really going on?

Regression Analysis: When several factors, such as prepaid subscriber percentage, income, and handset subsidization, affect a variable such as the handset replacement cycle, regression analysis can determine the impact of the different factors. More detailed analysis further revealed that, not surprisingly, handset subsidization was the dominant factor, far ahead of how people paid and their income levels.

Here is what the analysis determined:

$$Handset\ Replacement\ Cycle = 74.9\ Months + 0.000117 * Income - 0.0348\ Prepaid\ Percentage$$
$$-0.08696\ Handset\ Subsidy$$

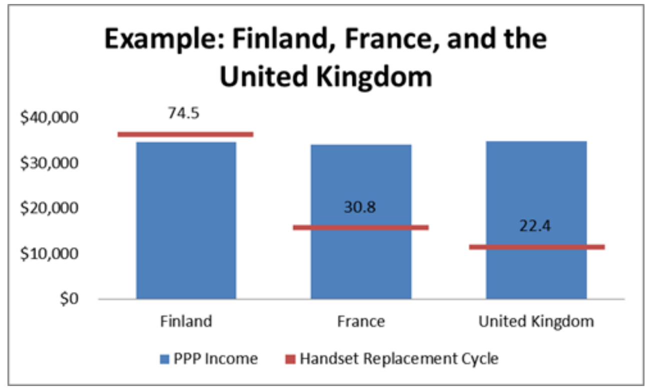
$r^2 = 0.64$

We first look at how well the formula explains the empirical data: An r^2 of 0.64 indicates that the formula used has good explanatory value, but not perfect.

Let's look at it by the various components.

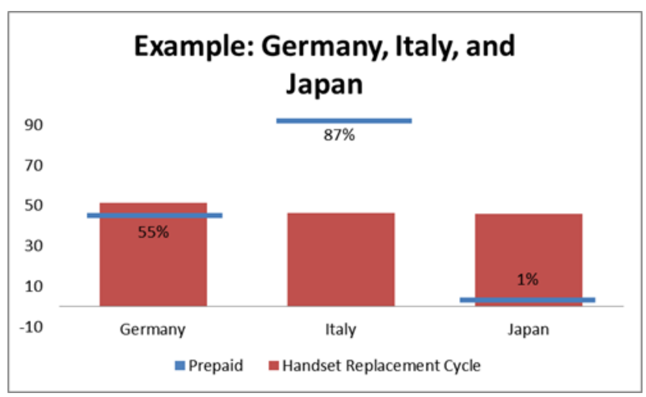
We will begin in purchase-power parity income. According to our analysis, for every dollar someone earns, the handset replacement cycle goes up by 0.000117. For every $10,000 in income the handset replacement cycle goes up by 1.1 months. The impact of income is modest, which is clear in a comparison between United States and Italy. The income differential between the two countries is roughly $18,000, which affects the handset replacement cycle by two months when the overall difference in the handset replacement cycle is about 30 months. Again, the direction is surprising, but the magnitude of the impact is small.

A good example to illustrate the lack of impact that income has is a comparison of Finland, France, and the United Kingdom. The average income in all three countries is almost identical: Finland with $34,585, France with $34,077 and the United Kingdom with $34,920. At the same time, the handset replacement cycle is remarkably different. As mentioned before, in Finland the handset replacement cycle is 74.6 months, while in France the average consumer replaces his or her handset every 30.8 months. In the United Kingdom, the average consumer changes their handset every 22.8 months, which is almost as quickly as consumers in the United States. The same income yet significantly different handset replacement times supports the findings of the analysis that income is a negligible factor in how quickly the handset gets replaced.



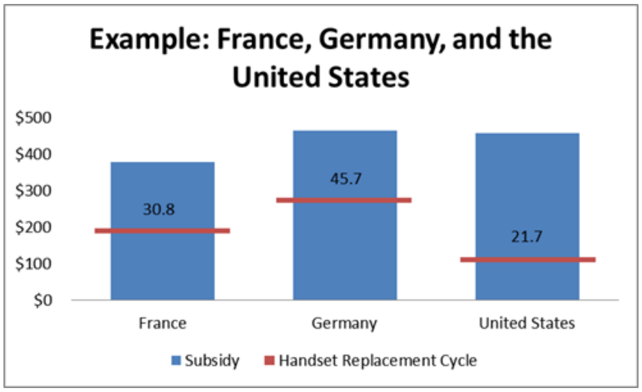
The next variable is the percentage of postpaid subscribers. For every 10% of postpaid subscribers the handset replacement cycle goes down by 0.3 months. While the direction is somewhat surprising, the relatively small magnitude of the increase is a lot more important. It shows that the handset replacement cycle is relatively unaffected by the way people pay their bills in a given country. The maximum difference in handset replacement cycle between a country with 100% prepaid and a country with 100% postpaid is about three and a half months compared to a baseline of 74.9 months or almost seven years.

The most interesting examples of a significant direct connection between the significance of prepaid and the handset replacement cycle are Germany, Japan, and Italy. The handset replacement cycle in all three countries is almost the same (between 45.7 and 51.1 months), whereas the percentage of customers using prepaid could not be more diverse: Japan is almost exclusively postpaid with only 1% of customers using prepaid; in Italy 87% of customers are on prepaid plans; in Germany the two payment options are almost equal, with 55% of customers choosing prepaid plans. The average income in all three countries is also close ranging from $29,392 in Italy versus $33,805 in Japan and $36,303 in Germany.



The final factor is the handset subsidy provided by the operator. For every $100 handset subsidy, the handset replacement cycle shortens by roughly 8.6 months. By directly lowering the price of the handset through a subsidy, the handset replacement cycle is most dramatically impacted. The price/value perception of the consumer is altered and the new device becomes even more attractive through its affordability.

The general trend is clear, as shown through the comparison of the United States and France, a greater handset subsidy generally leads to a faster replacement cycle. Nevertheless, the comparison of the United States and Germany shows that the relationship is far from perfect. While in both countries the devices are subsidized by about the same amount, the handset replacement cycle in the United States is far shorter. As we indicated at the beginning, an r^2 of 0.64 is a good fit, but not a perfect fit. There are other contributing factors which we will examine as this series continues. One of the contributing factors could be the lower cost of of wireless telecommunications and the higher consumer surplus that Americans are enjoying.



Conclusion and additional thoughts

Based on the data and analysis outlined in the report, it is conclusive that over the last four years, handset subsidization is the dominant factor influencing the handset replacement cycle. The percentage of subscribers on postpaid and prepaid plans, as well as the relative income level in the countries, had a negligible impact on the handset replacement cycle.

There is considerable empirical evidence to support the analysis. When the original iPhone was released, it was priced at $499 to consumers. Sticker shock ensued and sales were relatively modest—falling short of some overly exuberant forecasts. The iPhone became a mass market phenomenon when AT&T and Apple reworked their arrangement and AT&T increased its handset subsidy from the typical $150 to $200 level to the previously unprecedented $450, which allowed the handset price for consumers to come down to a more palatable $199. Another example is the situation in Finland, which for a long period of time outlawed handset subsidies. Since it lifted the ban it has only modestly adopted handset subsidization, and has one of the longest handset replacement cycles in the world—about six years. Therefore, Finns have some of the oldest devices in their hands and seem poised to miss out on the mobile Internet revolution.

Another myth can be laid to rest is that early termination fees are a barrier to consumers getting new handsets faster. For both the United States and Canada, where two-year and three-year contracts are the rule, consumers chose to upgrade their phones on average three months before the end of the contract. Contracts including handset subsidies and early termination fees that are used to protect the operator's investment are accelerating the handset replacement cycle rather than inhibiting it.

Americans are benefitting greatly from handset subsidies that allow them to have newer, more powerful devices than anyone else on the planet. Especially at times of rapid technological innovation, such as what we are observing right now with the smartphone revolution, the countries that make the most advanced technology quickly available to businesses and consumers will reap significant benefits from it. Not only do the devices become more powerful, but the software on the devices are innovating in a six to twelve months cycle compared to desktop operating system innovation cycles of several years. Entire new business sectors are created, such as mobile application development, which help existing companies reap the economic benefits of enhanced productivity. In addition, consumers are enjoying entire new ways of communication and doing some of their daily activities in unprecedented ways.

What has the rapid handset cycle brought us? Only four years ago, flip phones were the pinnacle of consumer trends. These devices had one inch screens, the size of a postage stamp, that had barely enough room to display the phone number and processing capabilities that were barely beyond that of a pocket calculator. When sending or receiving a text message with 140 characters, the user had to scroll down the screen twice. Data speeds were slow to the point where a tiny mobile website took half a minute to load. It would have been inconceivable for consumers to watch videos on four inch screens whose resolution is on par with that of a high-definition TV set. Social networking, something that today's wireless users take for granted, has been made possible through these new devices. Cameras and video capabilities that rival that of stand-alone devices have become the standard and people today are taking more pictures and videos than ever before in history. Low cost, high quality, and part of what people carry with them all the time. Due to the rapid handset replacement cycle, more than 37% of Americans own smartphones today. With smartphones, the power and capabilities of the Internet that only a few years ago were limited to a computer in the home or at work are now in the palm of your hand virtually anywhere you go. Ten years ago, the things we take for granted now were the very things we saw in a science fiction series – now we live with them every day.

Addendum

Handset replacement cycle: The handset replacement cycle describes the length of time in months that a device owner keeps his handset before purchasing a new one. It is calculated by first subtracting the number of new subscribers from the subscribers at the end of a year to get the number of long-term device owners. Then we subtract from the total number of device sales the number of net subscriber additions to determine the replacement device sales. Then the number of long-term device owners is divided by the number of replacement device sales and multiplied by 12. This results in the handset replacement cycle in months.

((subscribers – net subscriber additions) / (device sales – net subscriber additions)) * 12 = handset replacement cycle in months

Purchase power parity: The exchange rate at which the domestic purchasing power of both currency is equivalent.

ASP: Average Selling Price, the amount that the wireless operator pays for the device to the device manufacturer.

ATTACHMENT D

TOTAL CONSUMER SPEND ON WIRELESS SERVICES HAS DECLINED IN THE U.S., BUT USAGE IS UP. WHAT'S GOING ON?

From 2007 to 2010, Americans were spending 9% less on wireless as the smartphone revolution changes the way Americans use wireless

Executive Summary

Mobile voice and data services are nearly ubiquitous. More than 5 billion people use wireless, and one of the most common questions is: How much do you spend and how much does it cost? In order to better understand this, we have compared spending data in 14 countries[1] and across customers of 56 different service providers to get a comprehensive overview.

Never has it been cheaper and more affordable for Americans to use their wireless devices. Today, Americans pay less per voice minute, and for wireless services overall, than they did three years ago. This is not a universal trend. In four of the 14 countries studied, the overall bill has increased in the same period. However, in many countries, even the significant increase in wireless data demand and spending has been eclipsed by the decline in voice spending, leading to an overall decline in consumer spend for wireless worldwide. From 2007 to 2010, in the United States, wireless voice spending per customer has declined by more than $12 per month and total spending on wireless services has declined by more than $4 per month.

Nowhere in the world do people consume as many wireless services as in the United States - more minutes, more messages, and more data than anywhere else. The cost per unit is also lower in the United States than almost anywhere else, explaining the large quantities of minutes and megabytes that Americans use. American consumers use more than half a magnitude more wireless services than consumers anywhere else in the world.

What consumers can afford to purchase is a function of the income they earn. In the U.S., the average American needs to work for only one minute (before taxes) to purchase 19 minutes of talk time from most carriers. In Finland, one minute of work purchases only 5.1 minutes of talk time. In South Africa, a person has to work for 2 minutes to purchase 1 minute of talk time.

U.S. consumer surplus from lower wireless prices amounted to $448 billion in 2010. Stated differently, in 2010, every wireless subscriber in the United States could spend $1,480 on goods and services due to savings on their wireless spend in prior years.

[1] The countries selected: Brazil, Canada, Finland, France, Germany, India, Israel, Italy, Japan, Korea, Mexico, South Africa, the United Kingdom, and the United States. These countries were selected to provide a good comparison in terms of geographic and economic diversity as well as the different stages of wireless development, in terms of wireless penetration and wireless data usage.

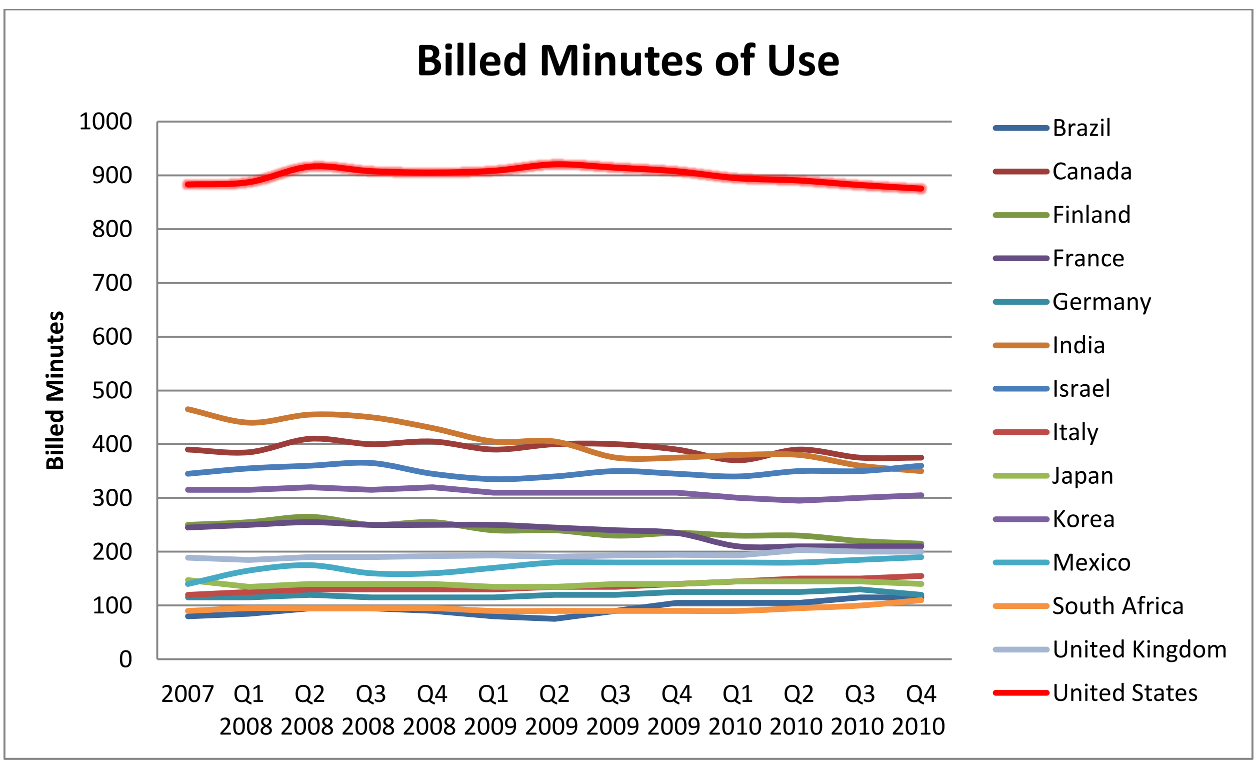
SPENDING TRENDS: VOICE AND DATA

In this chapter, we will discuss what people spend for their wireless services. It is important to differentiate between spending and price. Spending is the price multiplied by the quantity that has been purchased. The United States has some of the lowest prices for wireless voice and data and the highest usage. Americans get more value from wireless communications than anyone else. Americans are consistently spending less on their wireless voice communications in the last three years - from $45 per month to less than $33 per month. The decline in voice revenues is a global trend. In eight out of the 14 countries analyzed, including the United States, competition was so intense that the voice revenues declined, while subscriber numbers increased and minutes of voice use remained roughly flat.

At the same time, wireless data has transformed our lives. Mobile computers in the palm of our hand give us the power to access information, watch videos, and listen to music in ways that were pure science fiction only ten years ago. As a result, the amount that the average American spends on wireless data went from just below $6 in 2007 to just below $13 per month in 2010. The discrepancy between the huge increase in capabilities and utility that we enjoy through smartphones and the explosive growth in wireless data and the modest increase of just $7 per month is remarkable. Rarely have Americans received a better deal than that.

Combining wireless voice and data spend, Americans are spending $4.38 less a month on mobile communications than they did three years ago, while the ability and opportunity to do more with their minutes and their bytes has expanded in an unprecedented way.

We Talk a Lot: Minutes of Use



Source: Recon Analytics, 2011

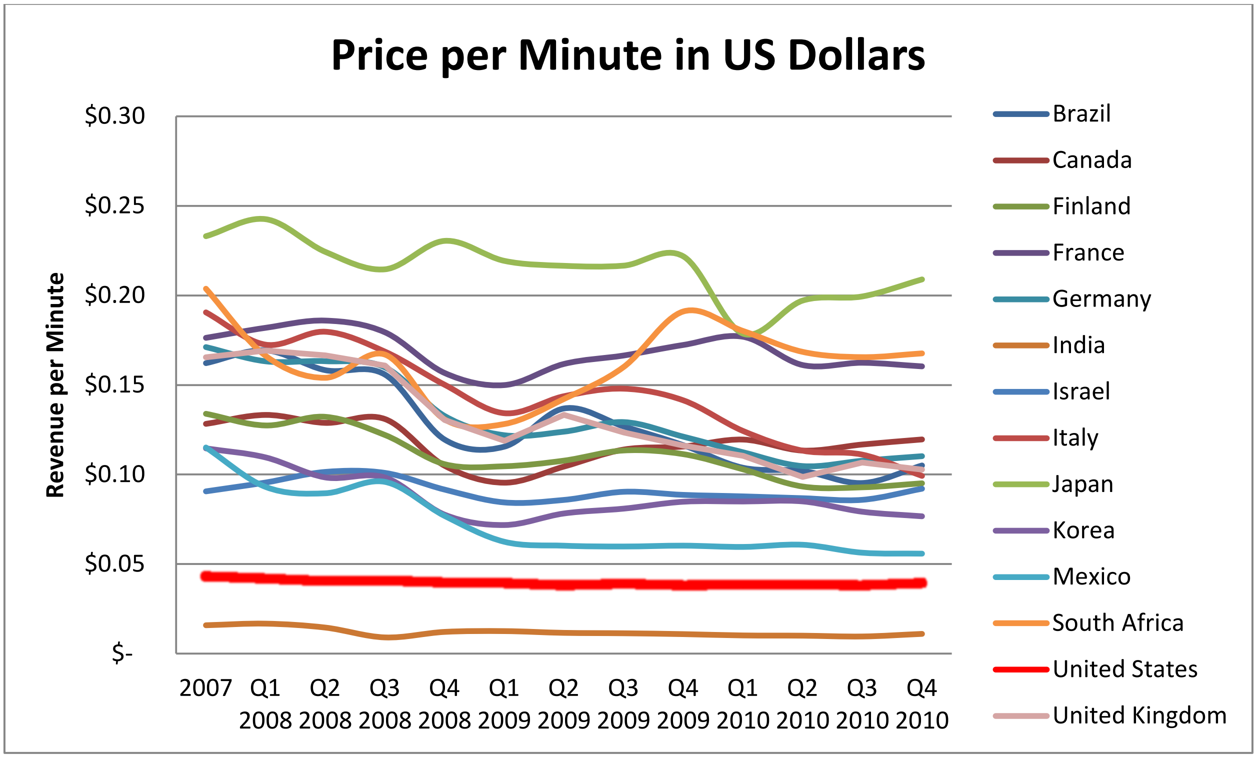
Using roughly 875 minutes a month in 2010, Americans talked more than most others on the planet, at least through their mobile devices, and more than the next two highest talking countries, Canada and Israel, combined. Canadians spend about 375 minutes and Israelis spend about 360 minutes per month talking on their mobile phone. The median talk time for the group of countries we studied is about 200 minutes. Finland, France and Mexico have talk times that are close to the median with 215, 210 and 190 minutes respectively.

What makes the period from 2007 to 2010 quite interesting is that it is the first time that average talk time is not uniformly increasing. While we see countries such as Brazil, Mexico, Italy, and South Africa experiencing 22% to 44% rises in talk time over the four years in question, average talk time in other countries, such as Finland, France and India, has decreased by 14% to 25%. Most other countries have seen their voice usage plateau, with their minutes of use going up or down by less than 5% in four years.

In the United States, the plateauing of wireless voice communications coincides with a dramatic increase of text messaging. According to CTIA's Semi-Annual Wireless Indices Report, Americans sent and received more than 363 billion text messages in 2007, which increased to more than 2 trillion in 2010. On a per-subscriber basis, usage increased from 129 messages per month in 2007 to 565 messages per month in 2010, which is an almost four-fold increase. This trend is replicated in other countries. According to Industry Canada, the telecom regulatory body in the country, Canadians sent and received approximately 235 messages a month in 2010, an increase from approximately 41 messages per month in 2007.

It's Really Cheap: Revenue per Minute in US Dollars

There is a good reason for the simply astonishing number of wireless voice minutes used in the United States. Almost nowhere else in the industrialized world is it as cheap to talk on a mobile phone than in the United States.



Source: Recon Analytics, 2011

In India, the effective price per minute is 1.1 cents, followed by the United States at 3.9 cents per minute and Mexico at 5.6 cents per minute. The most expensive countries are Japan at 20.9 cents per minute, South Africa at 16.8 cents per minute, and France at 16 cents per minute. In almost all countries, the effective price per minute has declined, with the sole exception of Israel, where prices increased by 2% from 2007 to the end of 2010. In the same time period, prices declined by 51% in Mexico, 48% in Italy, and 38% in the United Kingdom.

It comes as no surprise that generally, as price per minute falls, the number of minutes used increases. This relationship is especially strong in countries that have had relatively low usage and high prices. For example, both Brazil and Italy had some of the highest voice prices in the world; however, as the effective prices per minute fell by 35% in Brazil over the four year period we examined, the number of minutes rose by 44%. With prices falling in Italy by 48% over the four year period, minutes of use increased by 29%. The inverse is true. As effective prices per minute increase, usage typically declines.

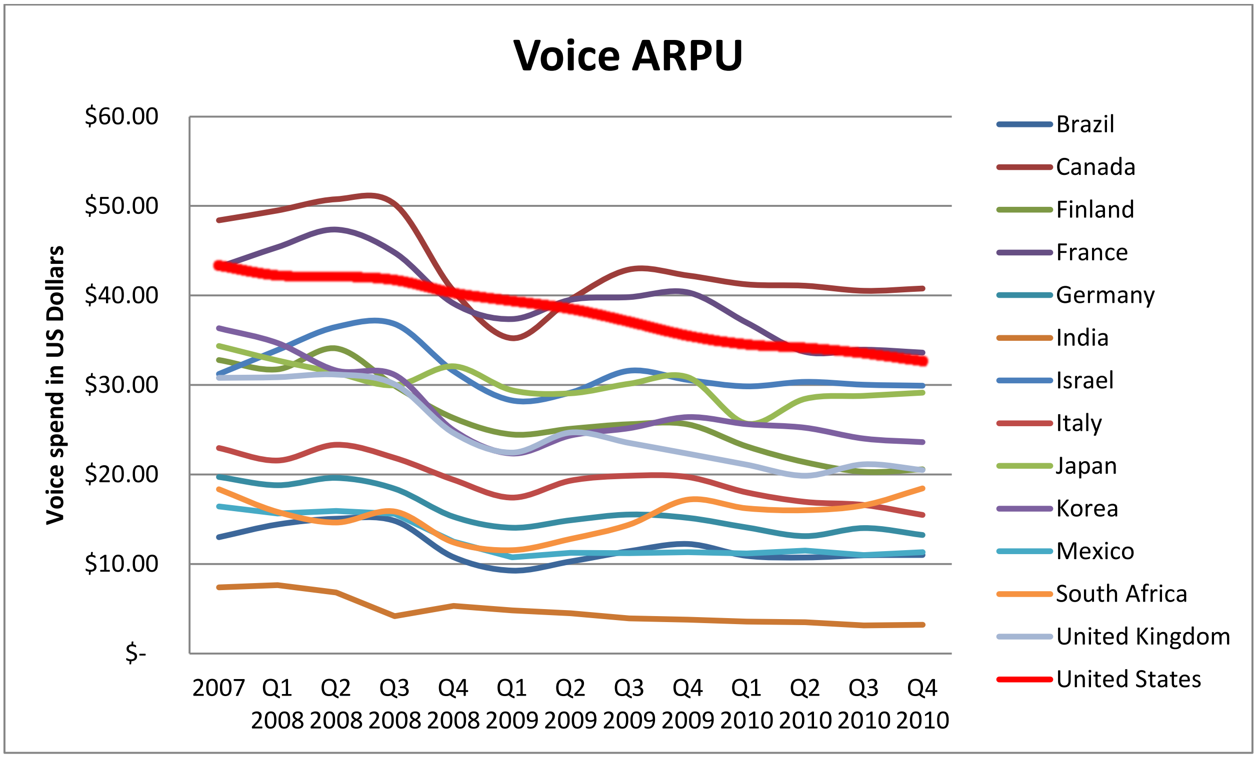
Change in effective price per minute from 2007 to 2010 and the effective price per minute in 2010

Brazil	↓35%	$0.105
Canada	↓7%	$0.120
Finland	↓29%	$0.095
France	↓9%	$0.160
Germany	↓36%	$0.110
India	↓30%	$0.011
Israel	↑2%	$0.083
Italy	↓48%	$0.099
Japan	↓10%	$0.209
Korea	↓33%	$0.077
Mexico	↓51%	$0.056
South Africa	↓18%	$0.168
United Kingdom	↓38%	$0.103
United States	↓9%	$0.039

Source: Recon Analytics, 2011

On the decline: Voice ARPU in US Dollars

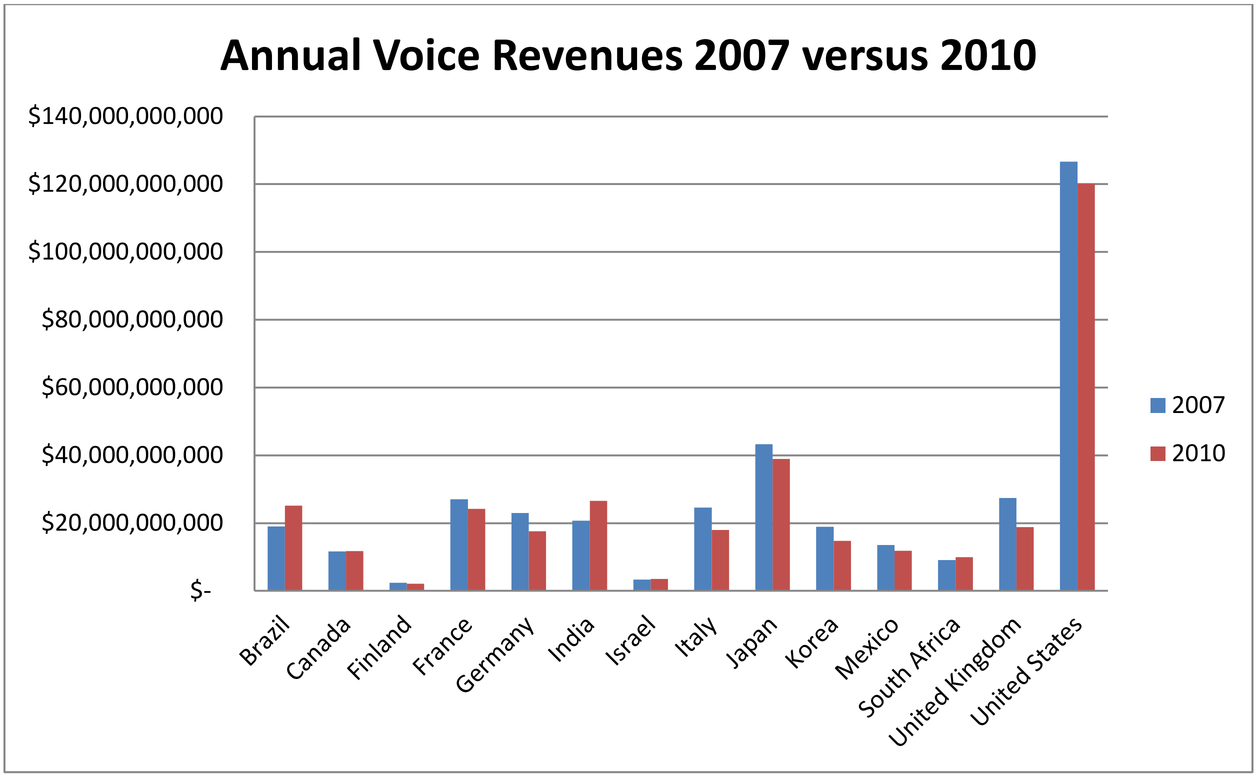
The previous chapters explored the relationship between price for services and usage, and how mobile voice usage has fluctuated over time. This chapter looks at what consumers in the 14 countries under review have actually paid for their wireless voice services.



Source: Recon Analytics, 2011

In the vast majority of countries we looked at for this report, we observed that the average customer spent less on wireless voice services than they did three years ago. In 2010, customers spent on average 25% less for voice communications than they did in 2007. Part of this decline is due to a real drop in prices, and part of it is due to an increase in secondary and even tertiary phones that consumers buy from different operators, splitting their spending among several operators.

South Africa is the only country where spending on wireless voice increased. The reason is that wireless voice usage increased faster than the price per minute declined. As a result, wireless voice spending increased by 1%. In percentage terms, voice spending fell the most in India with a 57% decline. Voice spending in India fell to make wireless affordable outside the big cities. While average income in India is $1265 per year, the average person in rural India earns significantly less. Without the decline in voice prices in India that lead to a decline in voice spend, wireless would have remained a luxury for the Indian upper class, rather than something the average Indian or even a farmer in rural India can use and afford.



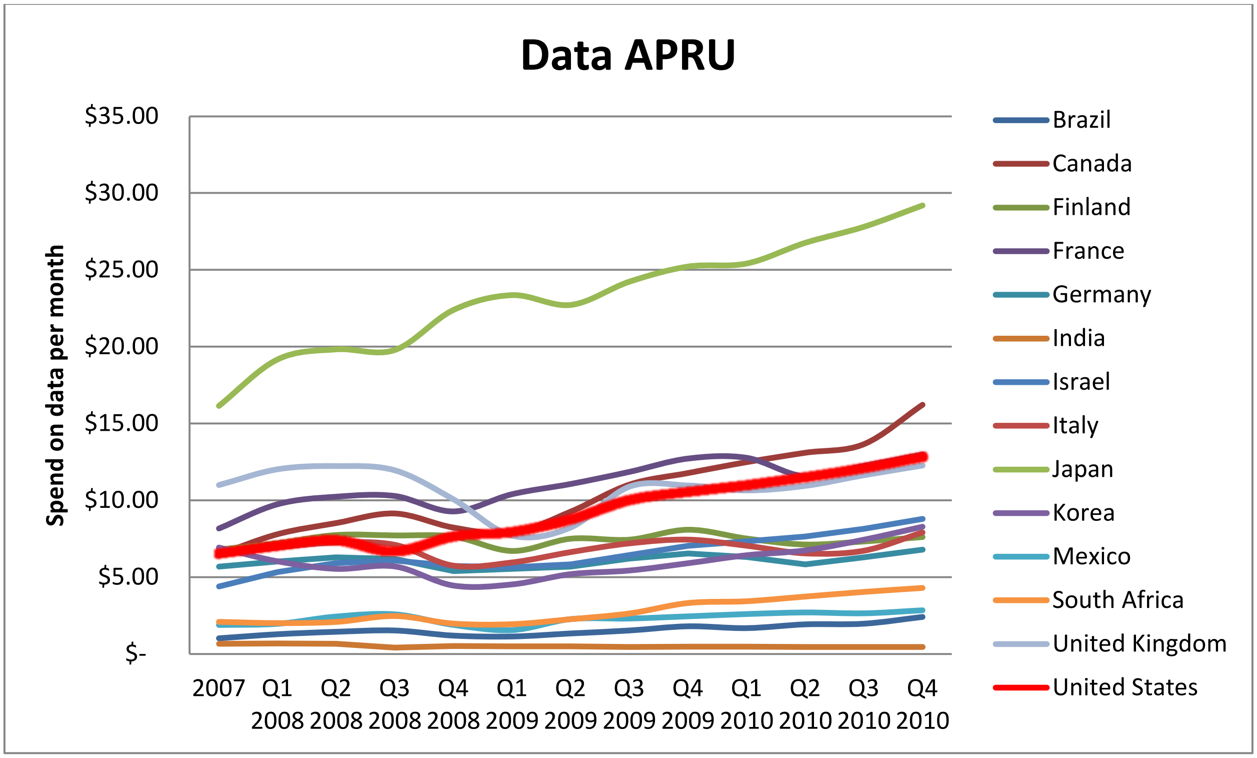
Source: Recon Analytics, 2011

Competition in voice services has been so intense that in 13 of the 14 countries observed, consumers spent less on voice service in 2010 than they did in 2007. In addition, in nine countries observed, the annual voice revenue for wireless carriers declined despite an increase in subscribers.

The analysis shows that voice ARPU levels and price declines are independent from how many carriers are active in a given country. It has a lot more to do with relative income levels, the extent of wireless penetration, and especially competitive intensity. Empirical evidence shows that a higher number of nationwide operators does not necessarily mean lower prices or faster falling prices. Among the countries observed, prices fell the fastest with six operators competing against each other. The second fastest price and spend decline was with three operators. Voice spending fell less with four competitors and even slower with five operators.

On the upswing: Data ARPU in US Dollars

While the user experience of a voice call is virtually identical around the globe—a call is a call, after all—wireless data services are a hodge-podge. Services are significantly different for the majority of users from country to country—and even within a country—depending on what handset a consumer uses and what network they have access to or have chosen to subscribe to. Data ARPU consists of revenue derived from text messaging, wireless Internet access, and at times even fees for voicemail and caller ID. In short, wireless data has come to mean just about anything that is not a wireless voice call. This fact makes comparisons among consumers of wireless data services a difficult task. This Chapter attempts to demonstrate that as wireless subscribers have adopted data services, the increase in usage has been by far greater than the increase in spending.

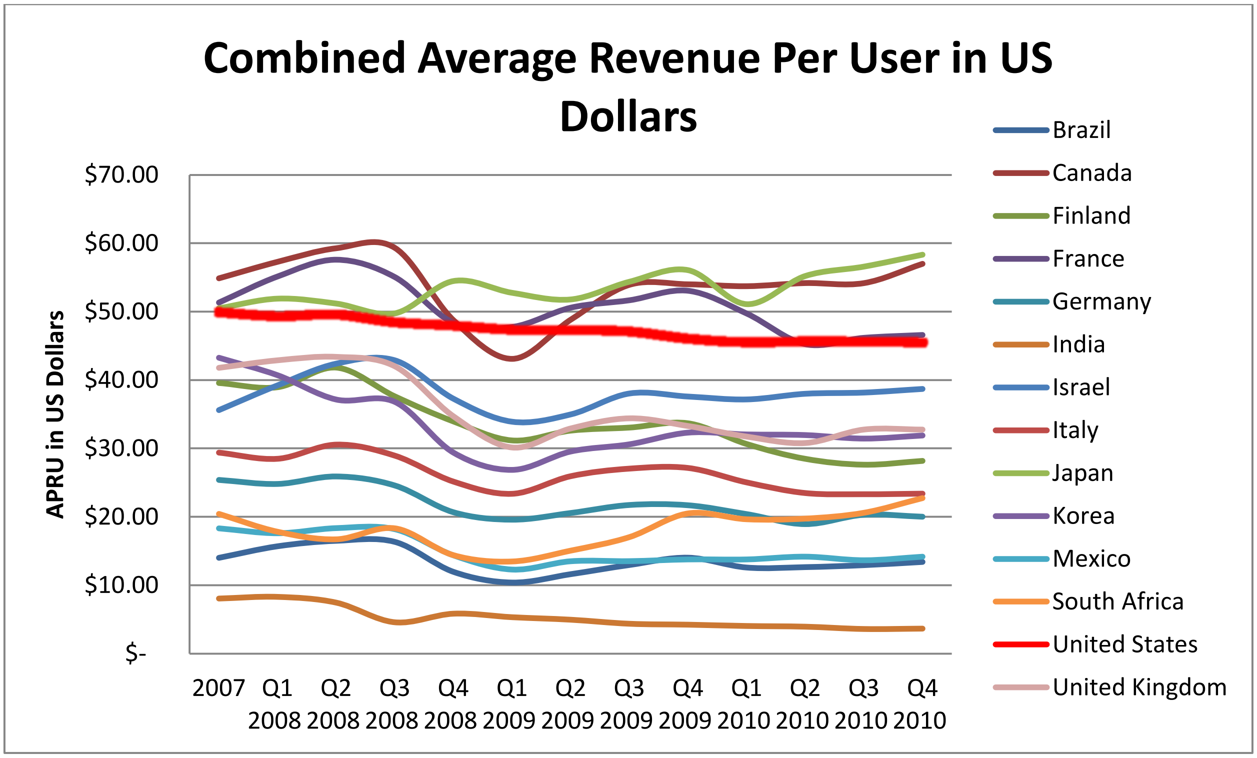


Source: Recon Analytics, 2011

Data ARPU has increased in every country we observed except India. In many countries, wireless customers spent twice as much on wireless data in 2010 as they did in 2007. It is important to note that the modest increase in data spend is due to higher usage, not higher prices. However, the total revenue from data has increased in all countries. On average, based on various operator reports, messaging revenues have doubled during the four year period, whereas data revenues have increased five-fold. The distribution between messaging and Internet data revenue is not consistent and does not follow any regional or developmental pattern. The growth rates give a good indication for the breakdown between the messaging and Internet components of data ARPU—countries with high data ARPU growth are more Internet-centric, whereas low data ARPU growth indicates messaging-centric data usage. This is consistent with the growth in smartphones that occurred during the same time period. Data ARPU is the highest in Japan, where in the four years from 2007 to 2010, it grew from $16.14 to $29.20, or about 81%. The second highest data ARPU is in Canada, with $16.22 which is 150% more than in 2007. The United States comes in at number three with $12.80, almost doubling since 2007. Similar to voice spend changes, data spend changes do not correlate with how many nationwide facilities-based operators are providing service in the country. In India, with six operators, spending on data fell by 31%; in Brazil, with five carriers, spending increased by 137%. Among the countries with four carriers, data spending increased by 61%, which was almost the same as in countries with three carriers, where it increased 59%. Again, we are unable to verify the economic orthodoxy that more competitors lead to faster price declines.

On the decline: Average Revenue per User

One of the most frequently quoted, but also misunderstood statistics, is the Average Revenue per User (ARPU) metric. ARPU measures what customers spend on average every month for voice and data services. As shown below, it is more an indication of the relative affluence of a country and operator performance than affordability or competitiveness.



Source: Recon Analytics, 2011

Overall ARPU has declined in ten of the fourteen countries studied. The largest increase in ARPU came in Japan (both in percentage and absolute values), with an increase of 16% (or $7.83) over the last four years. The second largest increase was in South Africa, where ARPU increased by 11% (or $2.31). In Israel, ARPU increased by $3.10 (or 9%), while in Canada ARPU went up by $2.12 (or 4%). In all of these countries, the increase in data ARPU significantly outpaced the decline in voice ARPU, resulting in an overall increase in ARPU. The reasons for declining data ARPU are two-fold: significant competition and, in the case of India, a significant expansion of lower income consumers.

India has the lowest ARPU among the fourteen countries observed. This is due to the expanding adoption of wireless among the lower income consumers in Indian. The next two lowest ARPU countries are Brazil and South Africa, which are also emerging economies with relatively low incomes. Indians pay $3.65 per month on average for wireless service for voice and data services combined, whereas Brazilians pay $13.40 and Mexicans pay $14.17, respectively, per month. The three highest ARPU countries are Japan, Canada, and France. The average Japanese wireless customer pays $58.33 per month, the average Canadian pays $57.00 per month, and the average French person pays $46.60. The United States is in the upper middle field of the pack with $45.52.

What is more telling than mere ARPU figures is putting them in the context of income, especially when considering how long the average person has to work for their gross income to equal what they spend on a wireless subscription.

Country	2010 Annual Income in US-$*	Minutes of Work to equal wireless ARPU	Minutes of Use	Minutes of Use per Minute of Work
Brazil	$10,816	82 (6)	115	1.4 (13)
Canada	$46,214	82 (6)	375	4.6 (3)
Finland	$44,488	42 (2)	215	5.1 (2)
France	$41,018	75 (5)	210	2.8 (8)
Germany	$40,631	33 (1)	120	3.7 (5)
India	$1,265	191 (13)	350	1.8 (11)
Israel	$28,685	89 (9)	360	4.0 (4)
Italy	$34,059	46 (10)	155	3.4 (6)
Japan	$42,820	90 (9)	140	1.6 (12)
Korea	$20,590	103 (12)	300	2.9 (7)
Mexico	$9,566	98 (11)	190	1.9 (10)
South Africa	$7,158	210 (14)	110	0.5 (14)
United Kingdom	$36,120	84 (8)	200	2.4 (9)
United States	$47,284	46 (3)	875	19.1 (1)

*Source: Recon Analytics, *International Monetary Fund, Rank in parenthesis*

When it comes to affordability, Americans lead the world: they can talk more than 19 minutes for every work minute. This is almost four times the Finnish mobile subscriber who gets 5.1 minutes of talk time for every minute they work. Unsurprisingly, the more affordable the talk time is, the more people consume. South Africans, who talk among the least with 110 minutes per month, also have to work the longest for it – two minutes of work for every minute of talk. While overall, it is expected that spending levels for wireless service in developing economies will be lower, some of the most advanced and revered wireless markets are also experiencing lower spending levels. Japan and Korea, countries that are heralded as paragons of innovation and progressiveness, are among the least affordable markets for domestic consumers. Affordability is a serious factor in the adoption of wireless services and the benefits that come with widespread adoption and usage of wireless. While the ownership of a wireless device is laudable, low usage and low engagement is signified by fewer minutes of use per month and a slower handset replacement cycle. What really drives the positive economic impact in is significant wireless usage. What positive economic impact is gained by wireless devices that nobody uses because they are not affordable enough to use regularly?

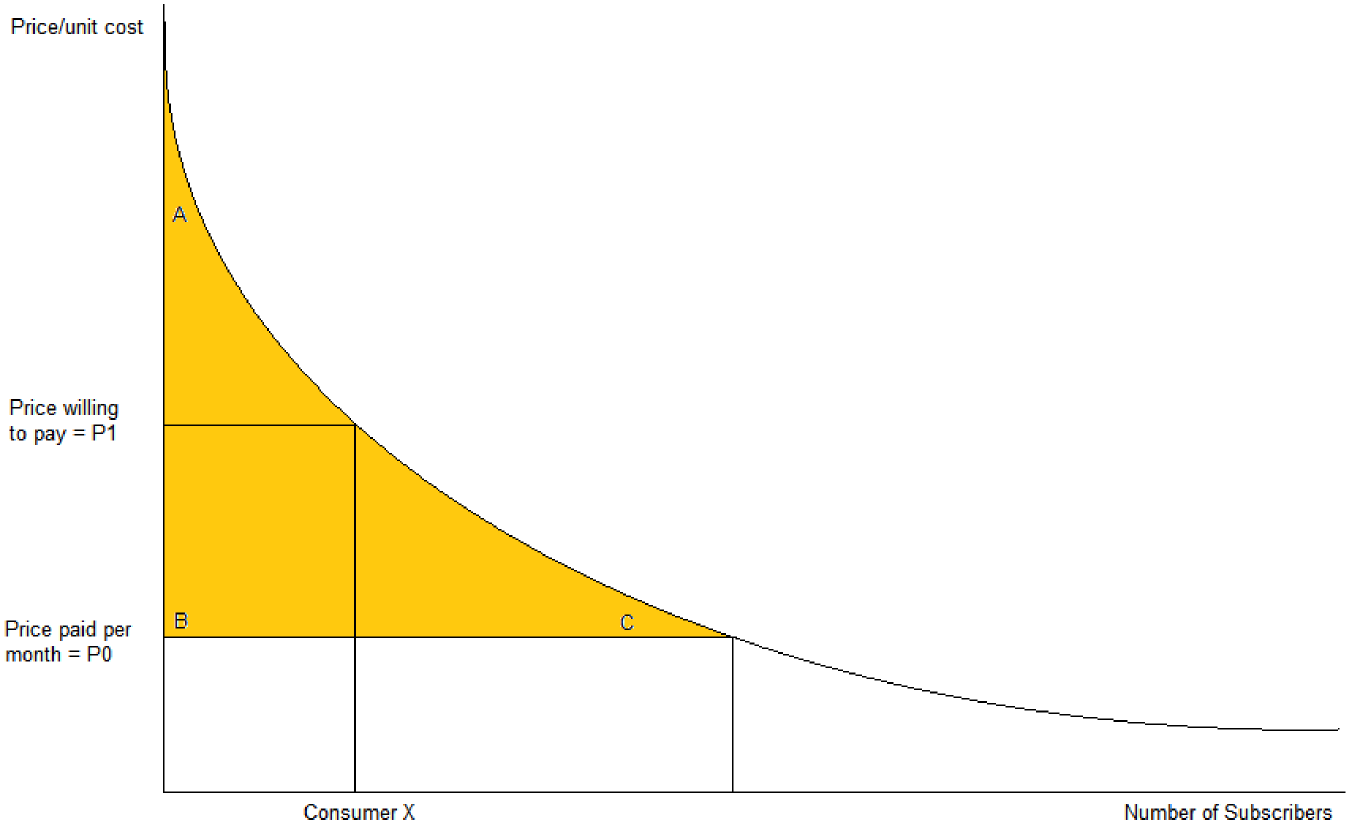
CONSUMER SURPLUS FOR VOICE SERVICES

Consumer surplus measures the difference between what people actually spend versus what they are willing to spend. We have reviewed all available studies estimating the consumer voice surplus for telecom services in the United States, Canada, and the United Kingdom.

- The 2010 wireless voice consumer surplus in the U.S. was at least $448 billion per year or $1,480 per wireless subscriber in the United States per year.
- This is an increase of $291 billion compared to 2004 when an Ovum/Indepen study determined that the wireless consumer surplus was at least $157 billion per year, demonstrating the continuing and increasing benefit that falling prices have for Americans.
- An Ovum report determined that the Canadian consumer surplus was at least CDN-$8.8 billion ($7.8 billion) or CDN-$264 ($233) per person per year. Prices have declined in Canada considerably less and usage has not increased as much as in the United States and therefore Canadians are benefitting monetarily considerably less - $233 versus $1,480 - than Americans.
- A Europe Economics report indicated that in 2006 the British consumer surplus was at least £17.7 billion ($32.7 billion) or £610 per person ($1,130.) Again, Britons have been able to reap fewer benefits from falling wireless prices than Americans.
- Compass Lexecon found that in 2009 the fixed broadband consumer surplus in the United States was $32 billion per year or $103 per person per year. The price declines in mobile and usage increases have yielded considerably higher savings for mobile subscribers than for fixed broadband subscribers.

In the United States, the consumer surplus has significantly increased over the six year period from 2004 to 2010. The consumer surplus increased by $291 billion per year to $448 billion in 2010. Due to the ongoing competition in the US wireless market, prices for voice services continue to be driven downward.

The consumer surplus is the amount that consumers are able to spend on other goods and services, and are therefore better off by that amount. The entire consumer surplus is depicted below by the yellow colored area ABC.

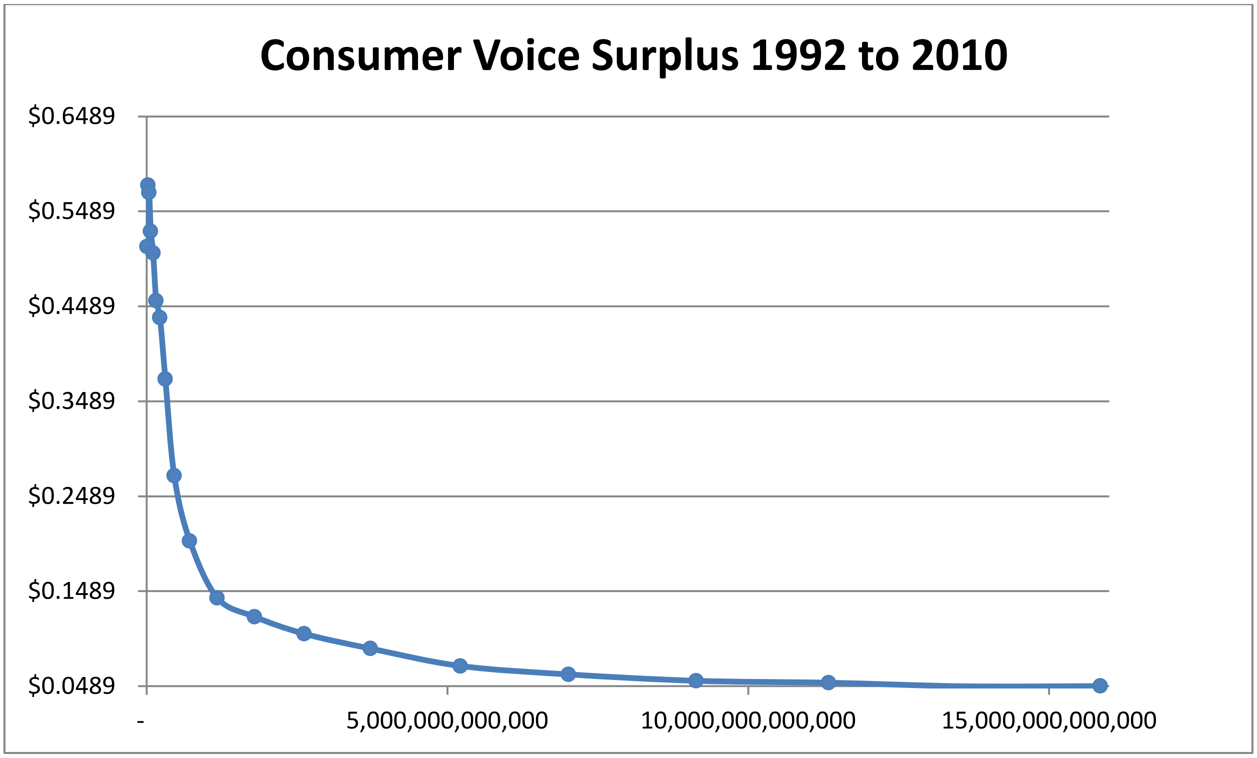


Source: Recon Analytics, 2011

The chart above also shows the consumer surplus for an individual. Consumer X would be willing to pay price P1, but due to the competition in the market, prices have declined to price P0. Through the price decline, Consumer X receives a consumer surplus of P1 minus P0, which he or she can spend on other activities, save or invest. The ABC area represents the entire consumer surplus from the earliest adopters to people that have just recently adopted wireless due to the low prices. The consumer surplus measures the entire benefit, both commercial and social, that wireless subscribers enjoy through wireless services.

The consumer surplus for wireless voice communications was $448 billion in 2010, or $1,480 per person per year. This is a significant increase from the last calculation I conducted as part of an Ovum/Indepen report called *The Impact of the US Wireless Telecom Industry on the US Economy* in September 2005, when David Levin and I calculated the total consumer surplus to be $157 billion per year based on 2004 figures. We found that almost all the consumer surplus in 2004 was derived from voice communications.[2] The almost tripling of the consumer surplus is due to a decline of the effective price per voice minute and an increase in usage. The effective price per minute fell from 8.6 cents in 2004 to 4.9 cents in 2010. In the same period, the amount of billable minutes increased from 559 million to 1.225 billion. In 2010 alone, more minutes were consumed in the United States than from the beginning of wireless communication to the year 2001 combined.

[2] Both calculations rely on data derived from CTIA's Semi-Annual Wireless Industry Indices Report.



Source: Recon Analytics, 2011

In the chart above, the lower bound of the consumer surplus is displayed as the entire area under the curve. This curve, with the number of minutes consumed instead of subscribers, was used because there is no empirical data to construct the demand curve to estimate the consumer surplus. Minutes of use uses a more conservative approach that underestimates the consumer surplus substantially. Consumers who were using wireless in the year 2000 at those prices are willing to use the same or more minutes at 2010 levels. This means that the true demand curve is to the right of the curve above.

Let's put this in context:

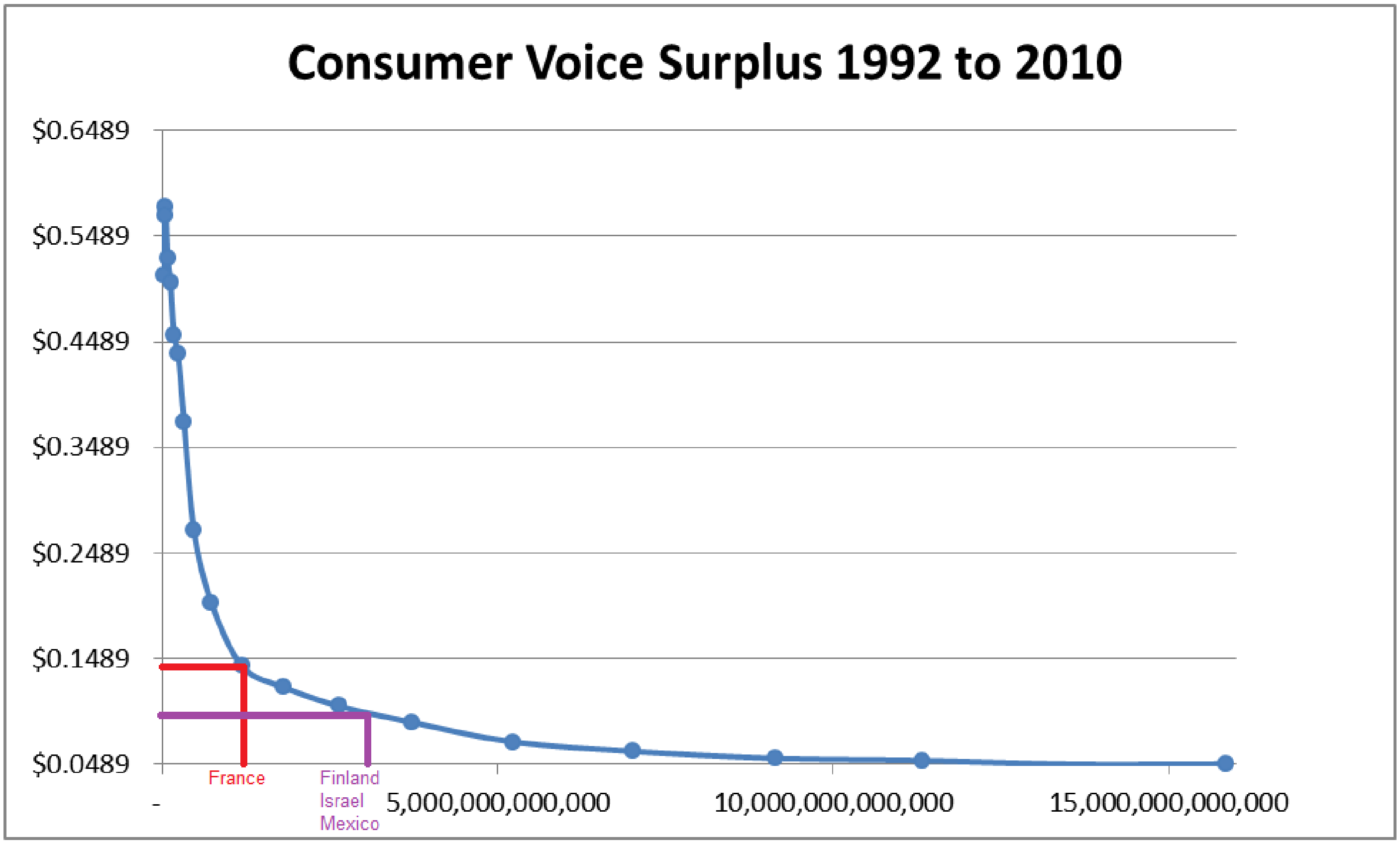
In 2004, the wireless economy had voice revenues of $97 billion and its consumer surplus was $157 billion, or roughly 1.6 times larger than service revenues. In the following six years until 2010, voice service revenues increased to $110 billion while the consumer surplus, due to rigorous competition increased to $448 billion, or roughly 4.1 times larger than the service revenues. This shows that in the last six years, consumers were the clear winners of wireless competition, with the consumer surplus increasing by 285%, while total service revenues only increased by 13%.

Let's look first at another segment that has been identified as critical to the competitiveness of the United States: Fixed Broadband. Mark Dutz, Jonathan Orszag, and Robert Willig from Compass Lexecon wrote a report[3] in 2009 that examined the consumer surplus of fixed broadband to consumers. Their calculations, based on Forrester Research's annual North American Benchmark Survey, concluded that the consumer surplus for fixed broadband was $32 billion per year, up from $20 billion per year in 2005. The wireless voice consumer surplus is more than 14 times that of the fixed broadband sector.

Internationally, there have been only a few studies looking at the consumer surplus created in various countries. In 2010, Ovum published a report on the Benefit of the Wireless Telecommunications Industry to the Canadian Economy and concluded that in 2008 the Canadian wireless consumer surplus was $8.8 billion. This compares to service revenues of $15.49 billion in the same year. Canada's 2008 wireless consumer surplus was only a little bit more than half of the industry's service revenues. Every Canadian benefitted from a consumer surplus of $264 per year.

[3] The Substantial Consumer Benefits of Broadband Connectivity for U.S. Households; Mark Dutz, Jonathan Orszag, and Robert Willig; Compass Lexecon, July 2009.

In 2006, Europe Economics published a paper on the economic impact of the use of radio spectrum in the United Kingdom. It found that the consumer surplus was £37.7 billion compared to service revenues of £17.7 billion or roughly 2.1 times larger than service revenues. This translates into a consumer surplus per person per year of £610 or $1,130 per United Kingdom resident.



Source: Recon Analytics, 2011

Plotting several other countries onto the US consumer voice surplus shows that the consumer voice surplus is still substantially larger than that of any other country we studied. Finland, Israel, and Mexico had the lowest effective price per minute outside the United States with 7.8 cents, 7.9 cents and 7.6 cents, respectively.

In comparison, the US surplus was 4.8 cents. If the purple horizontal line is the lower bound, then the current consumer surplus is about 30% larger than what would prevail at Finnish, Israeli, or Mexican price levels and more than twice as large as it would be if the US had French price levels.

Conclusion

Since 2007, the wireless industry has made a transformational change. The iPhone and other smartphones have dramatically rearranged the wireless landscape. In most countries studied, wireless has become more affordable. In many countries, the voice price declines have been so significant that the total voice revenue in the country actually declined. The overall amount Americans spend for wireless has declined by $4.38 per month from 2007 to 2010, predominantly driven by a dramatic decline in voice spend of $10.46 per month. In the United States, spend on wireless data has increased by $6.08 per month.

The United States has the highest usage among the countries we have studied and most likely in the world. At the same time, it has some of the lowest prices for voice and data services in the world. Only India, with average income levels that are 1/37th of the United States, has a lower cost per minute than the United States.

Through the falling prices in the United States, the consumer surplus increased in 2010 to $448 billion per year. This equates to $1,480 per year that every American wireless subscriber can spend on other goods and services through the lower wireless costs they have incurred through these price levels. This is a significant increase from the last calculation conducted as part of an Ovum/Indepen report six years ago where the total consumer surplus was computed to be $157 billion per year based on 2004 figures. This demonstrates the continuously increasing benefit that the mobile industry provides to the American people through lower prices. The consumer surplus computed in this report for the United States is higher, both on an absolute and on a per capital basis, than what has been published for any other country. The significant benefits that the American wireless industry is providing is highlighted through the comparison with similar studies performed overseas and for other technology segments: The consumer benefits that US wireless customers are enjoying are greater than anywhere else in the world.

Addendum

The following operators were studied for this report:

Brazil	**Germany**	**Italy**	**South Africa**
Claro	E-Plus	3	Vodacom
Oi	O2	TIM	MTN
Nextel	T-Mobile	Vodafone	**United Kingdom**
TIM	Vodafone	Wind	Everything Everywhere
Vivo	**India**	**Japan**	Orange
Canada	Bharti	NTT DoCoMo	O2
Bell Mobility	BSNL	KDDI au	T-Mobile
MTS	Idea	Softbank Mobile	3
Rogers Wireless	Reliance	**Korea**	Vodafone
Telus	Vodafone	LG Telecom	**United States**
Finland	**Israel**	Korea Telecom	AT&T
Elisa	Cellcom	SK Telecom	Leap Wireles
DNA	MIRS	**Mexico**	Metro PCS
Sonera	Partner	Iusacell	Sprint Nextel
France	Pelephone	Movistar	T-Mobile
Bouygues		Nextel	Verizon Wireless
Orange		Telcel	
SFR			